Organoleptic Evaluation of Pulse Based Low Fat Snacks for Diabetics

BY

AARATHI KRISHNA

(17PFD001)

A thesis submitted to

Avinashilingam Institute for Home Science and higher Education for Women, Coimbatore – 641 043

In partial fulfillment of the requirement for the Degree of

MASTER OF SCIENCE

IN FOOD SERVICE MANAGEMENT AND DIETETICS

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Saradha Ramadas 25.04.2019
Signature of the Head of the Department

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Signature of the Supervisor

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CHAPTER I

INTRODUCTION

Management of diabetes mellitus is becoming common today due to the high prevalence of diabetes among the population groups according to WHO (2018), diabetes has raised from 108 million in 1980 to 422 million in 2014 and the global prevalence of diabetes among adults over 18 years of age has raised from 4.7 % in 1980 to 8.5 % in 2014. In 2016 WHO reports that diabetes is a growing challenge in India with estimated 7.8% both males (7.9%) and females (7.5%). India is reported to have the second highest number of diabetic individuals in the world (ICMR-INDIAB, 2016).

The study conducted by Indian Council of Medical Research - INdia DIABetes (ICMR-INDIAB) in four different zones of rural and urban India, in which the weighed prevalence of diabetes was 10.4 % in Tamil Nadu and Coimbatore district has 532,863 diabetics (National health profile, 2018). To control the glycemic level, National Institute for Health and Care Excellence **(**2018) guideline 28 recommends reinforcing advice on diet, lifestyle and adherence to drug treatment for all people with type 2 diabetes.

Due to the consumption of Insulin tablets, their meal pattern and time has to be followed strictly to avoid hypoglycemia. In the dietary management of diabetes, quantity as well as quality of fat and carbohydrate intake must be carefully considered because they may not always grant desirable health benefits. The consumption of high-fiber, a low glycemic index (GI) carbohydrate has been shown of decreasing the risk for developing type II diabetes.

Pulse ingredients offer an abundance of nutritional advantages relevant to chronic disease and health issues of global concern. It is high in fiber, with ▫ 15–32% total dietary fiber; of this, approximately one-third to three-quarters is insoluble fiber and the remaining is soluble fiber. In comparison of cereal grains, legumes are good

source of proteins, dietary fibers, low glycemic indexes, low levels of fat (2-5%), and high amounts of carbohydrates (55-60%).

Pulses are considered low glycemic index foods (< 55) and therefore, digestion as well as absorption of low GI foods occur slowly, whereas for high GI foods occur rapidly, resulting in varied glycemic responses. It also reported that the replacement of high GI carbohydrates foods with a low GI resulted in the reduction of hypoglycemic episodes in patients on insulin (Kalpana et al., 2017).

Generally pulses are processed before consumption. A different type of processing has been carried out such as soaking, steaming, drying, cooking, and roasting Etc. Pulses are typically marketed and consumed in a variety of processed, rather than raw, forms. They are easily available in fully or semi-processed forms such as easy-to-store instant foods. Many pulses are soaked in water from 4 to 8 hours or more, which will dramatically reduce their phytate content, and cooking time and their propensity to cause flatulence. Soaking ensures that pulses can be more easily digested and their nutrients better absorbed by the body. In fact, soaking dried pulses for several hours brings them back to life, activating their enzymes and reduces anti-nutrients. The processing methods of tested study, the steamed one had highest crude protein content as compare to raw form of pulses.

Hence, low-fat foods which are pulse based help to maintain normo-glycemia and also it provides good rationale for the regular incorporation of pulses at approximately two-thirds of a cup daily in the management of hyperlipidemia in persons with type 2 diabetes. Pulses are low in calories (260-360 kcal/100 g dried pulses), high in complex carbohydrates and fiber, which means they are slowly digested and give a feeling of satiety.

Thus, resistant starch value is 3-5 times higher in conventional dry heated pulses and steamed pulses. Prolong steaming and short dry heating helps to decrease the enzymatically assessed total starch content, which is beneficial to prevent indigestion.

One among the developing countries such as India, the consumption of pulses is highly income-elastic, so the focus should be on establishing market linkages and stabilizing incomes for domestic producers. Another way to stimulate long-term consumption is by incorporating pulses in food aid programmes (FAO, 2016).

A high fat diet, especially nuts have a healthy nutritional profile and it is high in MUFA and PUFA, which are good source of vegetable protein and are rich in fibre, vitamins and minerals. Incorporation of nuts in the diet may therefore improve the overall nutritional quality of the diet. Nuts have minimal effects in rising postprandial blood glucose levels when eaten alone, and diminish the postprandial glycaemic response when consumed with high-glycaemic index carbohydrate foods in both normoglycaemic and type 2 diabetic individuals.

From the last few decades India has been experiencing many changes in the way of living pattern and also increased the demand for processed foods or Ready-To-Eat snacks. The increasing income and urbanization force the consumer to prefer more convenience, easy commercial availability processed foods with longer shelf life. These pulses based RTE snack items are impressive, versatile, and have controllable processing tools which produce a wide variety of food products, with enhanced shapes and nutritive value of the end product. Therefore, a judicious combination of convenience, cheaper and nutritious food in the form of pulse based RTE snacks is not only the choice for the diabetics but also it is a beneficial step to prevent developing diabetic nation. In the dietary management, low fat snacks which are pulse based helps to maintain normal glycaemia. Low calorie, high protein, high fiber, foods like legumes can be an ideal choice for diabetics. Snacking pattern is usually common among diabetics because of polyphagia and the selection of snacks is a huge problem because they have to eat the common fried foods which are available. So a pulse based low fat snack was proposed to be developed.

Hence, the present investigation was planned to develop pulses based low fat snacks for diabetics with the following objectives:

1. Develop pulse based low fat snacks suitable for diabetics
2. Standardize the developed products and study the acceptability

CHAPTER II

REVIEW OF LITERATURE

Review of Literature in support of "Organoleptic Evaluation of pulse based low fat snacks for Diabetics" is given under the following heads.

A. Diet-Cornerstone in diabetes management
B. Pulses-Super foods for diabetic management
C. Processing of pulses

A. Diet-Cornerstone in diabetes management

Oats is a super food, which is high in water soluble fiber (beta-glucan) and aids in the management of diabetes, hypercholesterolemia, hypertensive and weight management. This study revealed that oats can be easily incorporated with any Indian breads, breakfast items, snacks, and drinks with up to 50% partial replacement with oats component. Therefore, the modified traditional Indian products had acceptable sensory and textural characteristics (Preeti Khanna et al., 2017).

The use of extrusion technology for the production of ready-to-cook oats vermicelli is analyzed to check for the nutritional properties mainly for protein, starch and dietary fiber. Thus, this study revealed that oats vermicelli with oats flour was on par as compared to without oats flour, i.e., controlled vermicelli (Subbulakshmi et al., 2017).

Wheat bran to the diet would decrease in the risk factors of type 2 diabetes mellitus in overweight college students and also the wheat bran supplementation reduced body weight, and showed slight control over total cholesterol and LDL-C levels. Therefore, wheat bran could be recommended as a part of a healthy diet for overweight people (Althwab et al., 2013).

Rice is generally considered a high glycemic index (GI) food and the addition of pigeon pea to rice lowered its GI and increased resistant starch (RS) compared to other pulses, while *ghee* (clarified butter) showed more GI lowering and RS increasing effect compared with vegetable oils, when added during cooking. These findings emphasize the need to identify and develop rice with high RS and low GI. The GI of rice food can be further reduced by combining with suitable pulses and oil/fat (Awadhesh et al., 2018).

Low-fat vegetarian and vegan diets are associated with weight loss, and increases insulin sensitivity. Therefore, the effects of a low-fat vegan diet and conventional diabetes diet recommendations on glycemia, weight, and plasma lipids. Hence, both diets were associated with sustained reductions in weight and plasma lipid concentrations. In an analysis controlling for medication changes, a low-fat vegan diet appeared to improve glycemia and plasma lipids more than did conventional diabetes diet recommendations. Whether the observed differences provide clinical benefit for the macro or micro vascular complications of diabetes remains to be established (Barnard et al., 2009).

Randomized controlled trials has been demonstrated viscous soluble fibers have acute and long-term metabolic improvements in type 2 diabetes, such as reductions in hemoglobin A1C, fasting and postprandial glycemia, insulinemia. In addition, they may be helpful in weight control through promoting feelings of fullness. Increasing consumption of foods containing fiber or use of fiber supplements could play an important role in managing diabetes (Vladimir et al., 2009).

62 % fat replacement and 34.5 g of insulin content in the preparation of biscuit was acceptable with high score of overall acceptability. The replacement of fat and carbohydrate with insulin can provide a nutritionally enriched food product and also promote benefits without compromising on taste and texture (Uma Mageshwari et al., 2018).

Incorporation of mushroom powder (10%) improves nutritional quality of the recipes and findings clearly show that inclusion of Shiitake mushrooms offers new way of reducing the high GI observed with control recipes. Such products may have a potential use in the dietary management of Type 2 diabetics (Swati, 2013).

Knowledge and behavioral practices related to type 2 diabetes mellitus improve diabetes-related knowledge and may facilitate healthy eating in non-diabetic housemates. These findings suggest that having a chronic disease in the household provides an opportunity to improve health in the entire household and address the lack of knowledge about prevention of type 2 diabetes mellitus (Jannie et al., 2016).

The stevia plant and its products have potential for commercial uses as sweetener or therapeutic. Beside the two known main molecules that are intense sweeteners, occurring in stevia plant (stevioside and rebaudioside A) contain other compounds of nutritional importance for therapeutic uses. Therefore, the established procedures for isolation and purification of its glycosides and one of them have been approved for food use. Then, a solid market of diabetes-oriented products must emerge, for satisfying demands from these consumers (Elevina et al., 2016).

A study shows that plant-based omega 3s have different effects than marine-based omega 3s in relation to type 2 diabetes, it was opined that this may be possibly due to the contaminants present in fish. A group of people with metabolic syndrome were given omega-3 fatty acid supplements. Those taking the supplements were found to have lower markers of autoimmunity and inflammation, as well as more weight loss, compared to people who did not take the supplements (Olabiyi et al, 2013).

B. Pulses-Super foods for diabetic management

Whole or dehulled green gram have a low to intermediate glycemic index making pesarattu a good breakfast for diabetics in general. Whole green gram dosa has an edge over dehulled green gram dosa for its low glycemic index which can be readily

suggestible. *In vitro* digestibility of whole and dehulled green gram dosas significantly correlated with glycemic index and gave scope for selecting *in vitro* digestibility test in place of invasive glycemic index estimation (Salma, 2014).

Horsegram has excellent therapeutic properties and it possess anti-diabetic, anti-ulcer activity and also helps in dietary management of obesity due to the presence of beneficial bioactive compounds. Thus, the nutritional composition, antinutritional factors, medicinal properties and its possibilities to be exploited as functional/ medicinal food for health benefits (Bhartiya et al., 2015).

Pulse fiber is pectin rich, with most being found in the soluble fiber fraction. The soluble fiber fraction is a diverse mixture of polysaccharides of varying sizes and solutions of soluble fiber exhibit a range of viscosities depending on the pulse type. The sugars which make up the insoluble fiber fraction suggest a large cellulose component. After simulated upper-gut digestion, some starch remained inaccessible to digestive enzymes. Therefore, cell walls of pulses modulate starch gelatinization and reduce enzymatic hydrolysis, which may account for the low glycemic response attributed to pulses (Brummer et al., 2015).

Flours and fiber-rich fractions obtained from pulse crops can be incorporated into processed foods to increase dietary fiber content and/or serve as functional ingredients. Hereby, it focuses on research conducted in the past ten years on the non-starch polysaccharides and oligosaccharides found in dry beans (*Phaseolus vulgaris*), chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and dry peas (*Pisum sativum*). The isolation, composition, and structure of these pulse fibers are described (Susan et al., 2010).

Pulse components can use as value-added ingredients in foods formulated for blood glucose (BG) and food intake (FI) control requires. The objective of this study was to examine of the effects of pea components on FI at an ad libitum meal, as well as

appetite and BG responses before and after the meal. This study supports the use of pea components as value-added ingredients in foods designed to improve glycemic control (Mollard et al., 2014).

Pulses are low in energy density, supporting their inclusion in the diet for the management of risk factors of the metabolic syndrome (MetSyn). The aim of the present study was to describe the effects of frequent consumption (five cups/week over 8 weeks) of pulses (yellow peas, chickpeas, navy beans and lentils), compared with counselling to reduce energy intake by 2093 kJ/d (500 kcal/d), on risk factors of the MetSyn in two groups (nineteen and twenty-one subjects, respectively) of overweight or obese (mean BMI 32·8 kg/m2) adults. Therefore, frequent consumption of pulses in an *ad libitum* diet reduced risk factors of the MetSyn and these effects were equivalent, and in some instances stronger, than counselling for dietary energy reduction (Mollard et al., 2012).

Diet high in legumes may be beneficial for the prevention of type 2 diabetes mellitus. It has an inverse association between quintiles of total legume intake and 3 mutually exclusive legume groups (peanuts, soybeans, and other legumes) and type 2 diabetes mellitus incidence. Therefore, the consumption of legumes, soybeans in particular, was inversely associated with the risk of type 2 diabetes mellitus (Villegas et al., 2008).

Pulses (chickpeas, yellow peas, navy beans, lentils) have an effect on blood glucose (BG) and appetite following a fixed-size meal 2 h later. Over the following 2 h, all pulses lowered BG area under the curve (AUC) and lentils reduced appetite AUC compared with white bread ($p < 0.05$). Following the meal, BG was lower after lentils and chickpeas at 150 and 165 min, and AUC was lower after lentils compared with white bread ($p < 0.05$) (Mollard et al., 2014).

Pulses are low-glycemic appetite-suppressing foods, but it is not known whether these properties persist after being consumed as part of a meal and after a second meal.

The objective of this study was to determine the effects of a fixed-size pulse meal on appetite and blood glucose (BG) before and after an ad libitum test meal (pizza) and on food intake (FI) at the test meal. Therefore, the beneficial effects of consuming a pulse meal on appetite, FI at a later meal, and the BG response to a later meal are dependent on pulse type (Mollard et al., 2011).

Systematic review and meta-analysis of randomized controlled experimental trials by investigating the effect of pulses (chickpeas, beans, peas, lentils, etc.) which are low GI or high fibre diets and therefore, it is given to with and without diabetics. Thus, the pooled analysis of pulses alone or low-GI or high-fiber diets improve glycaemic level for longer duration in humans (Sievenpiper et al., 2009).

The pulses such as pea, lentil and chickpea shows the amount of slowly digestible starch (SDS) in the chickpea flour was highest among the pulse flours, but the resistant starch (RS) content was the lowest. The expected glycemic index (eGI) of lentil flour was lowest among the pulse flour (Hyun-Jung et al., 2008).

Chickpea is an important pulse crop grown and consumed all over the world, mainly in the Afro-Asian countries. It contains anti-nutritional factors like other pulses which can be eliminated by adopting different cooking techniques. Chickpea has three important sterols such as β-sitosterol, campesterol and stigmasterol. Therefore, the combination of chickpea with cereals and other pulses provide important health benefits to cure some of the important chronic diseases like type 2 diabetes mellitus, cardiovascular diseases, and some cancers (Aravind et al., 2012).

The bioaccessible as well as bioactive components, total phenols, tannins, and flavonoids were lesser in grains germinated in fortified water. Therefore, germinating pulses in fortified water can be used as a pre-processing technology for fortification of minerals (Morteza et al., 2017).

Chickpeas are rich in dietary fiber and polyunsaturated fatty acids and had the greatest single effect in reducing serum total cholesterol by 15.8 mg/dL. Therefore, polyunsaturated and saturated fatty acids had equivalent but opposing effects on serum total cholesterol and insulin (Pittaway et al., 2008).

Consumption of *Phaseolus vulgaris* bean species such as pinto, black, navy or kidney may be beneficial in the prevention and treatment of chronic diseases such as diabetes. The relationship between glycaemic concentrations and glycaemic response produced by the consumption of P. vulgaris species, and the impact that relationship may have on the risk of developing diabetes (Hutchins et al., 2012).

Dietary pulses including beans, lentils and chickpeas significantly reduced the relative PPG by 49% compared to an equicarbohydrate white bread control (RoM: 0.51, CI 0.45-0.57). Heterogeneity was moderate and statistically significant (I2=30%; $p<0.0001$), however this effect was consistent across all types of pulses and in mixed meals. Canned pulses showed a weaker effect. Therefore, dietary pulses in diabetic patients result in 50% significantly lower PPG rise compared to an equicarbohydrate white bread control (Livia et al., 2014).

All pulses led to lower blood glucose (BG) peak and cumulative area under the curve (AUC; 0–340 min); however, only chickpeas, lentils and navy beans reduced pre-pizza meal BG AUC (0–260 min) relative to pasta and sauce. Chickpeas led to lower post-pizza meal BG AUC (260–340 min) compared to navy beans and yellow peas. Therefore, consumption of pulses in a high-glycaemic meal contributes to earlier satiation, lower BG following the meal and after a later meal, but these effects are specific to pulse type and cannot be explained by their glycaemic properties alone (Mollard et al., 2012).

Legumes, including beans, chickpeas, and lentils, are among the lowest glycemic index (GI) foods and have been recommended in national diabetes mellitus (DM) guidelines. Therefore, this has been undertaken low-GI foods in type 2 diabetes mellitus

with a focus on legumes in the intervention. It improved both glycemic level and reduced calculated CHD risk (Jenkins et al., 2012).

Processing pulses to powdered form does not eliminate the benefits of whole pulses (beans, peas, chickpeas and lentils) on blood glucose response, lending support to the use of pulse powders as value-added food ingredients to moderate postprandial glycaemic response (Harvey et al., 2014).

C. Processing of pulses

Two gluten-free snacks, containing chickpea, plantain, and maize flours at different concentrations. Both the produced outcome helps to decrease weight gain, fasting serum glucose level and triglycerides. The product which has higher concentration of chickpea is more effect than the other one. Therefore, it proves that the developed product with chickpea flour have beneficial effect on the elimination of chronic disorders such as diabetes mellitus (Pamela et al., 2017).

Pinto, navy, and black beans were milled and it is extruded into puffs. The unflavored puffs were evaluated by untrained panelist by using 9 point hedonic scale. The total protein, crude fiber and phytic acid content in extrudates has minimal effect. But the total protein was significantly different in three pulses and total starch was not significantly different. The acceptability of pinto and navy bean was not much different but the black bean puffs has low acceptability. Thus, with the significant raffinose reduction support to reduce the loss of protein and fiber and the acceptability of unflavored extruded puffs support using various bean flours as ingredients in extruded puffed products (Courtney et al., 2015).

The objective of this study was to develop gluten-free, pulse-based cracker snacks that exploit the anti-allergenic and health-enhancing nature of pulses ingredients. Nine commercially available pulse fractions (chickpea, green and red lentil, yellow pea, pinto and navy bean flours and pea protein, starch and fiber isolates) were evaluated in a

model cracker formulation. The physical and nutritional characteristics of these pulse crackers were similar to existing products on the market. The products were scored highly during consumer acceptance testing. Interestingly, the percentage daily values per serving of iron in the chickpea crackers were 3–6 times higher than existing products. Therefore, it proves that pulse-based, gluten-free crackers have good potential for both consumer appeal and imparting health benefits (Jeeyup et al., 2010).

The effects of extrusion processing on fiber (soluble and insoluble), total available carbohydrates, tocopherols, organic acids, total phenolics, flavonols, hydroxycinnamic and hydroxybenzoic acids, as well as on the antioxidant capacity of different fibre-enriched lentil flours, were evaluated before and after extrusion process. Total dietary fibre was partially decreased after extrusion, which correlated with a significant increase in the soluble fibre fraction. This snack is enriched with gluten-free soluble and insoluble fibres, provide snack-type products with a balanced nutritional and antioxidants composition (Patricia et al., 2015).

The objective of this study was to identify and quantify the volatile flavor composition of selected Saskatchewan grown pulses including navy beans, red kidney beans, green lentils, and yellow peas, and to determine the flavor changes induced by thermal processing. Flavor profile of roasted flours, ground roasted seeds, pre-cooked seeds, pre-cooked slurries, pre-cooked–freeze-dried, and pre-cooked–spray-dried flours was studied using headspace solid-phase micro extraction gas chromatography/mass spectrometry. Hence, volatile profiles of pulses and the flavor changes occurred following different types of thermal processing could ensure better quality control of raw materials and help product developers meet flavor-delivery challenges. The relevant information may also be of interest to relevant industries targeting specific pulse-based food product development (Zhen Ma et al., 2015).

Isoelectric precipitation (IEP) and ultrafiltration (UF) were optimised for the extraction of proteins from yellow pea, desi and kabuli chickpeas, red and green

lentils. The functional properties varied to some extent as a function of the type of pulse and manufacturing process. Water holding capacity was highest for IEP-processed yellow pea and lowest for the UF-processed desi and kabuli chickpeas. Emulsifying properties and foam expansion were generally higher for the chickpea concentrates but they had less foam stability. Protein extracts from green lentils appeared to have the best gelling properties. The results highlight the technological potential of pulse protein extracts for food applications (Boye et al., 2010).

The extrusion cooking process converts the protein in its amorphous defatted flour form to fibrous structures. An extruded snack from Bengal gram brokens-sorghum blends was prepared by using Wenger X-5 extruder. The properties of the extrudates were studied at three different moisture levels, and three levels of barrel temperature with 5 levels of blending ratio of Bengal gram brokens-sorghum blends. The best quality extruded snack was obtained at 80°C barrel temperature, 15% moisture content of feed and 10% blending ratio followed by 15% moisture content of feed and 10% blending ratio at 100°C barrel temperature. Texture analysis of the optimized extrudate was also done for crispiness test and hardness test to have an idea of the resistance that the snack may offer on first bite to the consumer. The maximum value of crispness and minimum hardness was obtained at 15% moisture content, 100°C temperature (Sanjeev et al., 2014).

The biochemical and physicochemical functionalities of seed coats of six globally important pulses has been taken such as chickpea, field pea, faba/broad bean, lentil and mung bean with a special emphasis on the emerging food pulse lupin. Hence, the high levels of dietary fiber, minerals and potential health-promoting phytochemicals in the seed coats indicate their great potential to be used as a natural “nutritious dietary fibre” (Liezhou et al., 2018).

Grain legumes such as dry field pea (Pisum sativum) as major ingredients in snack foods may help to increase the nutritional appeal of foods. Pea based expanded

snack foods were developed using formulations varying in pea flour, pea fiber and pea starch and extrusion processing temperature. The products' physical characteristics, including shear strength, bulk density and expansion index, were characterized. The incorporation of pea fiber had the greatest effect on the texture of the final product whereas the addition of pea flour only slightly affected the physical properties of the product. Temperature also had an effect on the physical properties bulk density and expansion ratio but had no significant effect on the shear strength of the extrudates. Hence, the objective texture tests indicated that pea based puffed sample characteristics were comparable to commercial samples made of corn ingredients (Heather el al., 2015).

Trypsin inhibitor activity, functional properties, and microstructural characteristics of flours prepared from different varieties of lentil, chickpea, and pea as affected by roasting and boiling were evaluated. Hence, it is suggested that thermally-treated pulse flours may have very good potential to be used as value-added food ingredients for food applications due to their improved nutritional value and, in some instances, superior functionality (Zhen Ma et al., 2011).

Total carbohydrates, mono-, di- and oligosaccharides, and soluble and insoluble dietary fiber were determined before and after extrusion cooking under specific processing conditions. However, extrusion processing decreased the concentration of the raffinose family of oligosaccharides (raffinose and stachyose) in pulse extrudates. Formulated pulse flours demonstrated a beneficial increase in dietary fiber. This research indicates that value-added, nutritious snacks with reduced levels of flatulence factors and higher contents of dietary fiber can be fabricated successfully by extrusion processing of formulations based on lentil, dry pea or chickpea, and represent good alternatives to traditional cereal-based snacks. Also, the commercialization of value-added, pulse-based snacks would increase pulse consumption (Jose et al., 2010).

CHAPTER III

METHODOLOGY

The research design pertaining to the study “Organoleptic Evaluation of pulse based low fat snacks for Diabetics" is presented under the following headings.

A. Selection of the Ingredients
B. Development of the products
C. Standardization and sensory evaluation of the developed products
D. Nutrient content of the developed products

A. SELECTION OF THE INGREDIENTS

Snacking pattern is usually common among diabetics because of polyphagia and the selection of snacks is a huge problem because they have to eat the common fried foods which are available. So a pulse based low fat snack was proposed to be developed. To develop the snack, foods from four food groups were selected namely cereals, pulses, green leafy vegetables, nuts and oil seeds, and spices and condiments. The ingredients selected for the formulation of products is given below.

CEREAL

Wheat was selected from the cereal food group because it contains protein, fat, carbohydrate, dietary fiber and helps to maintain blood glucose level. Wheat is very high in fiber, containing both soluble and insoluble fibers. Soluble fiber helps to decrease blood cholesterol levels and control blood sugar levels, and insoluble fibers helps in digestion (Rukiye et al., 2019).

Whole wheat is a rich source of vitamins, minerals, phytochemicals, and lignans. Compared with refined flours, whole wheat generally has a lower glycemic index because of their intact structure. Constituents of whole wheat, including magnesium and

antioxidants such as vitamin E, phytic acid, and selenium, may help to maintain glucose and insulin homeostasis and helps to reduce the risk **(**Eva Qing Ye et al., 2012).

As Rukiye et al., in 2019 points out wheat contains both Beta (β)-glucans and soluble fibres which have multi-functional and bioactive characteristics. β-glucans are important compounds for achieving decreased postprandial glucose and insulin responses, and different mechanisms. The consumption of β-glucans and β-glucan-included products with whole wheat play an important role in management of diabetes by reducing the risk of diabetes-associated complications.

PULSES

Pulses are considered as health foods or super foods because of their many health benefits, including low glycemic index. They are good source of proteins, dietary fibers, low levels of fat (2-5%), and high amounts of carbohydrates (55-60%). Pulses are low in calories (260-360 kcal/100 g dried pulses), high in complex sugars and fiber and hence they were selected for the development of the product. Seven pulses namely bengal gram, black gram, dried pea, brown cowpea, green gram, horse gram, and whole Lentil were selected.

a. Bengal gram (*Cicer arietinum*) contain a-glucosidase and a-amylase enzyme at different concentration. Inhibition of a-glucosidase and a-amylase, enzymes involved in the digestion of carbohydrates, can significantly decrease the postprandial increase of blood glucose after a mixed carbohydrate diet and therefore can be an important strategy in the management of postprandial blood glucose level in type 2diabetic patients and borderline patients. It also helps lower cholesterol levels and hypercholesterolemia. The chickpea constituents (protein, fat, fiber, saponins, isoflavones) were believed to be involved in the normalization of the lipid metabolism and therefore have the potential to contribute to the management of type 2 diabetes (Prathapan et al., 2010).

b. Black gram (*Phaseolus mungo*) helps to normalize the diabetes and it showed appreciable lowering of blood glucose, serum total lipids, triglycerides and esterified portion of cholesterol. It contain high amount of protein and antioxidant capacity with respect to the dietary antioxidants (β-carotene, ascorbic acid) especially in sprouted black gram. Therefore, inclusion of the black gram shows reduction in the risk of total cholesterol/phospholipid ratio and several chronic diseases including diabetes mellitus (Geethanjali et al., 2008).

c. Dried pea (*Pisum sativum*) helps to lower cholesterol also help in managing blood-sugar disorders since their high fiber content prevents blood sugar levels from rising rapidly after a meal. (George., 2015)

d. Brown cowpea (*Vigna unguiculata (L.) Walp*.) contain health beneficial properties, including anti-diabetic, anti-hyperlipidemic, anti-cancer, and anti-hypertensive properties. The prevention of chronic diseases such as diabetes, the most proven are attributed to the presence of compounds such as soluble and insoluble dietary fiber, phytochemicals, proteins and peptides in cowpea (Jayathilake et al., 2018). Dietary fiber is also indigestible along the digestive tract of humans. Researches says that processing of cow pea improve digestibility of Galactose-Oligosaccharides (GOS), Protein, and Starch content (Yann., 2012).

e. Green gram (*Vigna Radiata*) is considered to be a low glycemic index carbohydrate. Mung bean starch contains approximately 8% of resistant starch and it is likely that both the high amylose content and the presence of resistant starch formed from retrogradation in thermal processing contribute to the low glycemic index (Salma, 2014) and hence this pulse was selected.

f. Horse gram (*Macrotyloma uniflorum*) is a potential grain legume having excellent nutritional and remedial properties. Horse gram has been recognized as potential source of protein and other nutrients. Horse gram is low in fat and excellent source

of protein, dietary fiber, a variety of micronutrients and phytochemicals (Bhartiya et al., 2015) and therefore this pulse was selected.

g. Whole Lentil (*Lens culinaris*) is a type of bean with both nutritional and pharmaceutical properties. This bean contains proteins, soluble and insoluble fibers, probiotic carbohydrate and minerals. As Malihe in 2018 points out there is evidence confirming the effect of lentil on the prevention and treatment of diabetes and controls type II diabetes mellitus.

NUTS AND OILSEEDS

Nuts have a healthy nutritional profile, high in MUFA and PUFA, are a good source of vegetable protein and are rich in fibre, vitamins and minerals. Incorporation of nuts in the diet may therefore improve the overall nutritional quality of the diet. Nuts have minimal effects in rising postprandial blood glucose levels when eaten alone, and diminish the postprandial glycaemic response when consumed with high-glycaemic index carbohydrate foods in both normoglycaemic and type 2 diabetic individuals and hence were selected for the development of the products.

a. Almond (*Prunus dulcis*) consumption is associated with ameliorations in hyperglycemia. Incorporation of almonds into a healthy diet has beneficial effects on glycemic control, and the lipid profile, thereby it decreases the risk of developing type 2 diabetic mellitus (Sing-Chung et al., 2010).

b. Pumpkin seeds (*Curcurbita maxima*) are rich in oil and nutrients. It is used as a potentially attractive source of lipid, protein and crude fibre. It is rich source of linoleic acid, which is useful to cure chronic diseases such as diabetes. Curcurbita seeds contained globulins with significant anti-hyperglycaemic activity and it possess hypoglycemic properties that could assist in maintaining glycemic control (Ahsan et al., 2015).

GREEN LEAFY VEGETABLES (GLVs)

Green leafy vegetables can be a good alternative to replace or at least supplement to western medications, which is naturally available from the surroundings. Several herbal medications have been proven to be clinically effective; because green leafy vegetables are considered to be relatively safe and it is used to treat type 2 diabetes mellitus can target multiple mechanisms including enhancement of insulin sensitivity, stimulation of insulin secretion, or reduction of carbohydrate absorption. Green Leafy Vegetables are likewise esteemed for people with type 2 diabetes because of their high Mg content, high fiber substance and low glycemic record. This contains a decent mix of polyphenols and also helps to manage hyperlipidemia. Hence, these were selected for the development of the products.

a. Curry leaves (*Murraya koenigii*.) and coriander leaves (*Coriandrum sativum*) are most consumed leaves in various diets of Indian cuisines. Both leaves are rich in many bioactive compounds like polyphenols, alkaloids and flavonoids which showed multiple bioactive functions like antioxidant, antimicrobial and anti-diabetic. The active compounds present in curry leaves are Mahanimbine, which helps to secret adequate amount of insulin and also to manage glucose level whereas, coriander leaves and seeds are also well reported for their antidiabetic activity by increased release of insulin from the pancreatic cells (Ganesan et al., 2013).
b. Mint leaves (*Mentha arvensis, Lamiaceae*) are commonly used as a spice and flavoring agent in food processing. Mint has an anti-inflammatory, antiseptic effect on the body. Mint is popularly known as a carminative that is used to provide relief from gastric discomforts, while also working as an antispasmodic, a stimulant and a stomachic that aids in providing a better appetite (Sharangi et al., 2013). Mint constituents have a therapeutic potential in the treatment for the prevention of diabetes mellitus, inflammatory disease, spamogenic disorder, and peptic ulcer. Research studies confirm that mint leaves significantly diminish the blood glucose level and improve the lipid profile (Abdul et al., 2011).

SPICES AND CONDIMENTS

The spices used in Indian cooking have the potential use in both preventive and therapeutic medicine and it is used in the treatment of the symptoms of metabolic syndrome such as hyperglycaemia, increased blood pressure, dyslipidaemia and insulin resistance. This section deals with the possible therapeutic benefits of the spices in the treatment of the symptoms of metabolic syndrome, in particular because of their anti-oxidant or anti-inflammatory effects. Hence, these were selected for the development of the products.

a. Red chili powders are valued as a spice for their pungent taste and red color and it is important as a flavor enhancer, vegetable and component in herbal medicine. In addition, chili powder possesses anti-inflammatory, anti-diabetic, anti-microbial, anti-cholesteremic, anti-clotting and antioxidant activities. Red chili powder intake may ameliorate insulin sensitivity and oxidative stress in type 2 diabetes mellitus (Chamikara et al., 2016).
b. Turmeric powder is a perennial herb, yielding a rhizome widely used as a culinary ingredient. Curcuminoids constitute 5 percent of the turmeric rhizome and have been widely examined for possible therapeutic effects in the symptoms of metabolic syndrome. In *in vitro* studies, turmeric prevented protein glycosylation and lipid peroxidation induced by high glucose concentrations (Abishek Iyer et al., 2009).
c. Asafoetida is an important medicinal spices belonging to the Apiaceae, traditionally used for the treatment of different diseases and recent pharmacological and biological studies have shown its anti-diabetic activities. Recent pharmaceutical and biological studies have also shown several activities, such as antioxidant, antiviral, antimicrobial, antispasmodic and hypotensive and antidiabetic. Therefore, this study suggest that Feralu assafoetida through DPP-IV inhibitory activities can be involved in the blood glucose control and could be recommended for the treatment of type 2 diabetes (Adel et al., 2017).

d. Salt is used as a seasoning to enhance the taste of food and according to the public health guidelines recommendation, salt leads to significant and clinically relevant falls in BP in individuals who are early on in the progression of diabetes mellitus with normal or mildly raised BP (Rebecca et al., 2016).

B. DEVELOPMENT OF THE PRODUCTS

Using the ingredients selected for the formulation of the products, four commonly consumed snacks like whole pulse mixture (combination of one cereal and pulses), Vadaam, Murukku, and Ribbon Pakoda were developed.

WHOLE PULSE MIXTURE

Standard mixture is a crispy snack which is referred with different names and each region has a subtle variation to each other, some may include fried dry coconut, others include corn flakes, fried green peas, cashews, groundnuts and fried lentils. This spicy and crunchy snack usually is consumed with evening tea. Basically, it is made of besan and incorporation other spices but in this study, it has been developed by using various whole pulses, dried leaves powder, spices, and nuts. It is a protein rich food with low fat and high fiber, which tastes nutty, crunchy & spicy.

VADAM

Sandige or vadam is a fried snack, originated from Tamil Nadu, Karnataka and Andhra Pradesh. It is also severed as an accompaniment with meals. It is a paste made from rice, sago etc. that is dried and then fried before using. In this study, vadaam is developed by using variety of pulse flour, banana flour, green leaves and nuts.

MURUKKU

Murukkku is a savoury, crunchy snack which is made from rice flour and urad dal flour. Murukku is especially popular in the states of Tamil nadu, Kerala & Andhra Pradesh. In this study, murukku is developed from variety of pulses, leaves, nuts and wheat.

RIBBON PAKODA

Ribbon pakoda is one of the most famous savouries in Tamil nadu. People call it by different names as ola pakoda/ oatu pakoda/ ribbon tape/ ribbon flowers etc. These are developed usually by using butter to obtain crunchy pakoda. It is usually consumed with tea as evening snack. The ribbon pakoda came out in brownish cream color due to the incorporation of variety of pulses, leaves, nuts and wheat. It is usually consumed with tea as evening snack.

C. STANDARDIZATION AND SENSORY EVALUATION OF THE DEVELOPED PRODUCTS

The first step in standardizing a new recipe is to analyze the proportion of ingredients and clarity of instructions, and to determine whether the recipe can be produced with the equipment and personnel available. It is also important to assess the portion size defined for the original recipe to determine whether it is appropriate for the customer and financial objectives of the operation. The recipe should then be tested. When doing so, make sure ingredients are weighed and measured accurately and that procedures are followed exactly. The yield, number, and size of portions as well as problems with preparation should be recorded (West and Woods's Introduction to Foodservice, 1997).

Hence, the first phase of the recipe standardization is the recipe verification phase. This phase includes 4 processes and that were followed in the standardization of four products namely:

1. Review of the recipe
2. Preparation of the recipe
3. Verify the recipe yield
4. Record changes to the recipe

After the standardization of the products, sensory evaluation is often described using the definition of institute of food technology – a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the sense of sight, smell, touch, taste and hearing (Sensory evaluation: A practical handbook, 2009). Sensory evaluation was conducted with the help of score card 9-point hedonic scale and it was prepared on the basis of appearance, color, flavor, texture and taste. The 85 untrained and 50 trained panel members were asked to make their independent evaluation of the products by marking their responses in the score card.

Hedonic rating relates to pleasurable or unpleasurable experiences. The hedonic rating test is used to measure the consumer acceptability of food products. From one to four samples are served to the panelist at one session. They were asked to rate the acceptability of the product on a scale, usually of 9 points, ranging from 'like extremely' to 'dislike extremely'.

The formulated and standardized products such as Whole pulse mixture, Vadam, Murukku and Ribbon Pakoda was analyzed for its organoleptic characteristics. Samples of whole pulse mixture, vadams, and murukkus were randomly given to 60 panel members (30 male and 30 female) who varied from 30-60 years of age. Distribution of ribbon pakoda for sensory evaluation was made on 50 diabetic panel members (25 male and 25 female) and to 25 non-diabetic panel members who varied from 30-60 years of age. After, the respective filled in score card were collected and consolidated to obtain the scores marked for all the 4 products prepared with oil and without oil were compared respectively.

The scores were then subjected to statistical analysis by using one way ANOVA and it was analyzed between diabetic and non-diabetic patients by giving ribbon pakoda.

D. NUTRIENT CONTENT OF THE DEVELOPED PRODUCTS

Most foods contain almost all the nutrients in various proportions, some foods being rich in certain nutrients. Depending on the relative concentration of these nutrients, foods are classified as protein rich foods, carbohydrate rich foods and fat rich foods etc. Protein, fat and carbohydrate are sometimes referred to as proximate principles. They are oxidized in the body to yield energy which the body needs (Nutritive value of Indian foods, 1971).

In this study, the nutrient content of the developed products was calculated with and without the incorporation of oil along with all other ingredients. The nutrients namely energy, carbohydrate, protein, fat and dietary fiber of the standard and the developed product was calculated for 25g.

CHAPTER IV

RESULT AND DISCUSSION

The result and discussion pertaining to the study “Organoleptic Evaluation of Pulse based Low Fat Snacks for Diabetics" is presented under the following headings.

A. Development and standardization of the products
B. Details on the sensory evaluation of the developed products
C. Nutrient content of the developed products

A. DEVELOPMENT AND STANDARDIZATION OF THE PRODUCTS

The procedures and methods towards the development of the four products namely whole pulse mixture, Vadaam, Murukku, and Ribbon Pakoda are described below in detail.

WHOLE PULSE MIXTURE

Mixture is the combination of different pulses, legumes and nuts available at home. Seven pulses were used for making this snack. It is a protein rich mixture that tastes nutty, crunchy & spicy.

Table I

Ingredients for whole pulse mixture

INGREDIENTS	QUANTITY (g/ml)	PROCESSING
Bengal gram	5	Cleaned and soaked for 20 hours
Dry pea	5	Cleaned and soaked for 12 hours
Roasted bengal gram	20	Cleaned
Brown cow pea	8	Cleaned and soaked for 12 hours
Black gram	10	Cleaned and roasted
Brown lentil	5	Cleaned and soaked for 8 hours
Green gram	8	Cleaned and roasted
Horse gram	8	Cleaned and soaked for 8 hours
Curry leaves powder	½ tsp	Cleaned and sundried
Mint leaves powder	½ tsp	Cleaned and sundried
Coriander leaves powder	½ tsp	Cleaned and sundried
Almonds	5	Cleaned and roasted
Pumpkin seeds	5	Cleaned and roasted
Turmeric powder	2	Sieved
Red chili powder	5	Sieved
Hing	3	Sieved
Salt	5	Dissolve in water and sprinkle over the ingredients
Oil (only one variation)	5	
TOTAL	100 g	
Yield = 100g Portion per serving = 25g Total number of portions = 4		

PROCEDURE

- Clean and soak the pulses overnight (Bengal gram, Dry pea, Brown cow pea, Brown lentil, Horse gram)
- Drain the water and sundry till it becomes dry
- Clean and sundry curry leaves, coriander leaves and mint leaves
- Roast all the pulses in a wok by adopting high temperature short time (HTST) method at 200°C for 3 minutes
- Roast curry leaves, coriander leaves and mint leaves
- Roast nuts (almonds and pumpkin seeds)
- Powder the roasted leaves and sieve it
- Mix all together by incorporating roasted pulses, powdered leaves, nuts and spices (Turmeric powder, Red chili powder, Asafoetida and salt)
- Add oil to the mixture

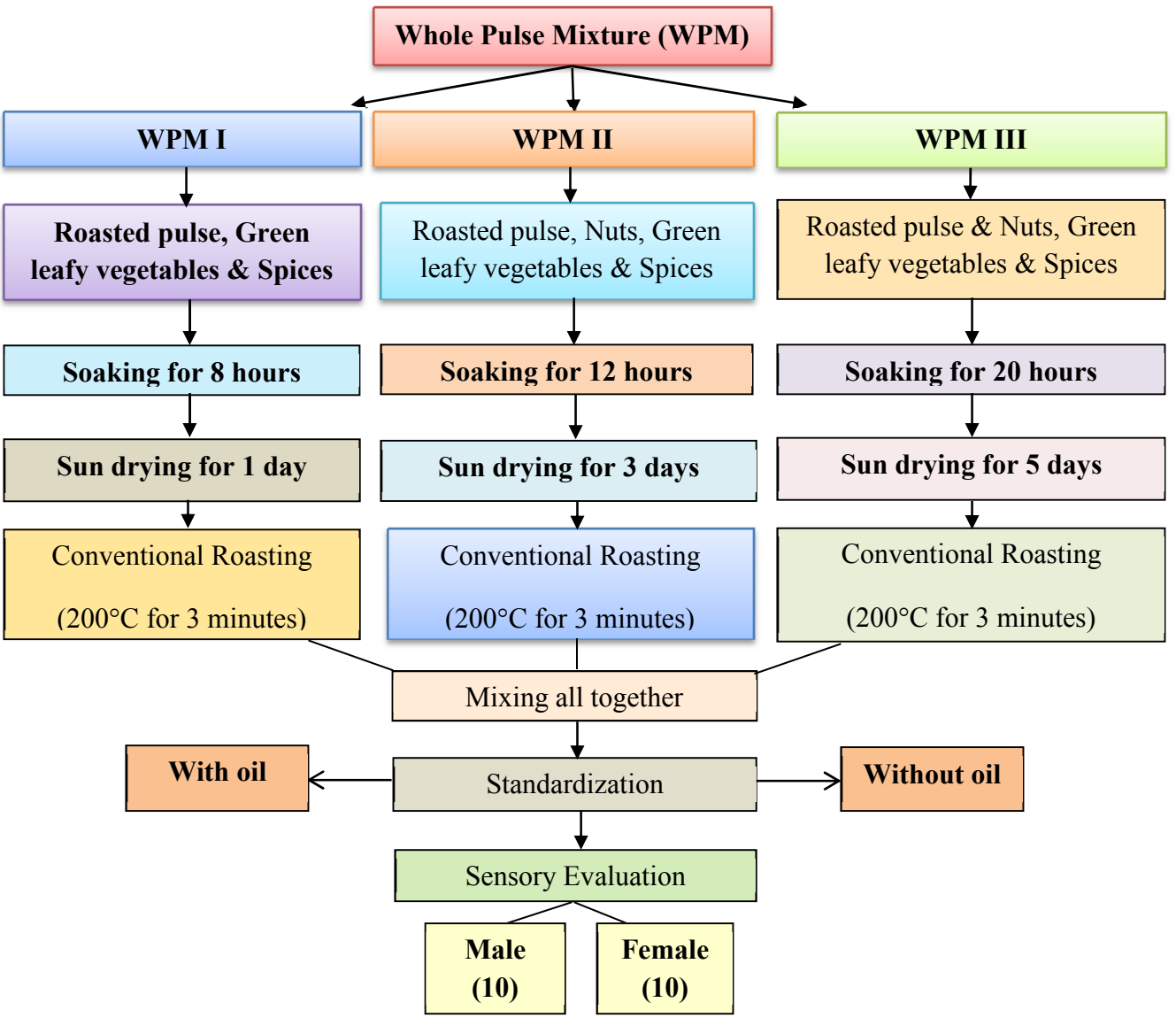
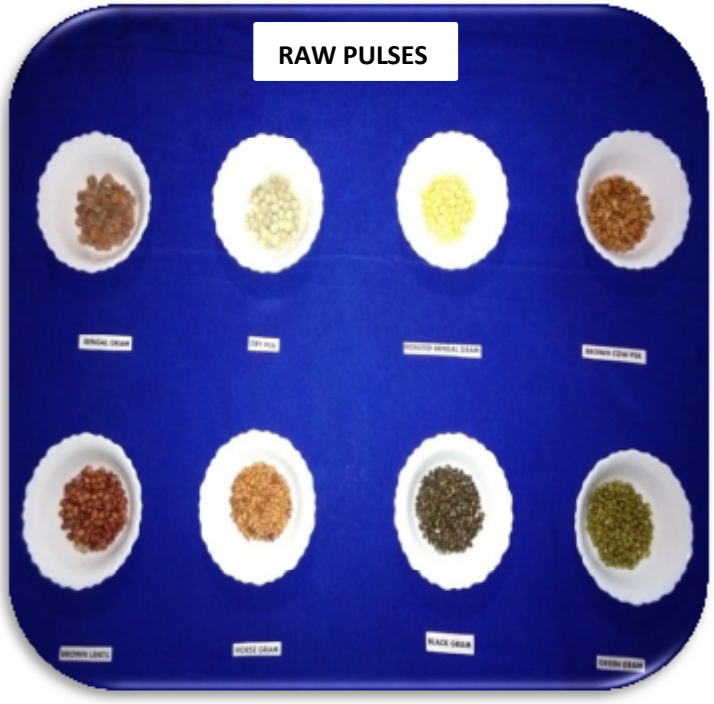
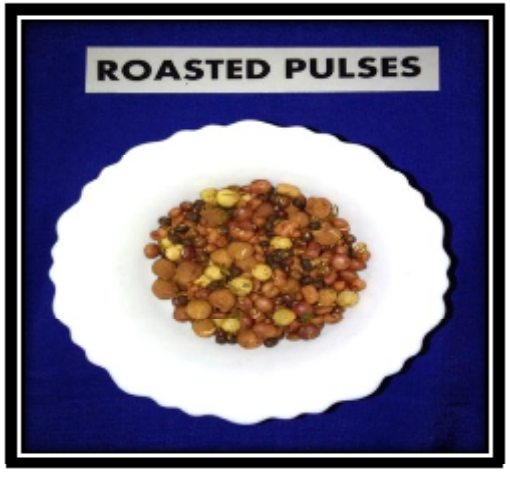
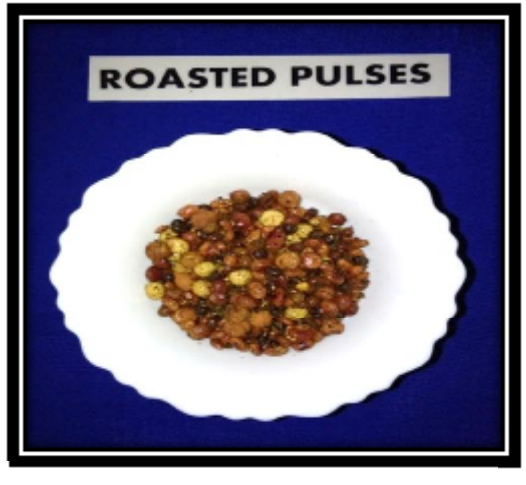


Fig. I : Flow chart of the whole pulse mixture







Roasted pulses without oil **Roasted pulses with oil**

PLATE I: DEVELOPMENT OF WHOLE PULSE MIXTURE

The standardization of whole pulse mixture was carried out three times each in three different variations by yielding 100g for both variables i.e., with oil and without oil preparation. Hence, the 100g of yield gives 25g of portion per serving i.e., total number of portion is 4 respectively.

VADAAM

Sandige or vadam is a fried snack, originated from Tamil Nadu, Karnataka and Andhra Pradesh. It is also severed as an accompaniment with meals. It is paste made from rice, sago etc. that is dried and then fried before using.

Table II

Ingredients for vadaam

INGREDIENTS	QUANTITY (g/ml)	PROCESSING
Bengal gram	5	Cleaned and soaked for 20 hours
Dry pea	5	Cleaned and soaked for 12 hours
Roasted bengal gram	20	Cleaned
Brown cow pea	5	Cleaned and soaked for 12 hours
Black gram	10	Cleaned and roasted
Brown lentil	5	Cleaned and soaked for 8 hours
Green gram	5	Cleaned and roasted
Horse gram	5	Cleaned and soaked for 8 hours
Banana flour/Wheat flour	5	Powdered, roasted and sieved
Curry leaves powder	½ tsp	Cleaned and sundried
Mint leaves powder	½ tsp	Cleaned and sundried
Coriander leaves powder	½ tsp	Cleaned and sundried
Almonds	5	Cleaned and roasted
Pumpkin seeds	5	Cleaned and roasted
Turmeric powder	2	Sieved
Red chili powder	5	Sieved
Hing	3	Sieved
Salt	5	Dissolve in water and sprinkle over the ingredients
Oil (only one variation)	5	
TOTAL	100 g	
Yield = 100g Portion per serving = 25g Total number of portions = 4		

PROCEDURE

- Clean and soak the pulses overnight (Bengal gram, Dry pea, Brown cow pea, Brown lentil, Horse gram)
- Drain the water and sundry till it becomes dry
- Clean and sundry curry leaves, coriander leaves and mint leaves
- Roast all the pulses in a wok by adopting high temperature short time (HTST) method at 200°C for 3 minutes
- Roast curry leaves, coriander leaves and mint leaves
- Roast nuts (almonds and pumpkin seeds)
- Powder the roasted leaves and sieve it
- Mix all together by incorporating roasted pulses, powdered leaves, nuts and spices (Turmeric powder, Red chili powder, Asafoetida and salt)
- Powder all together
- Make into a thick paste by adding water (normal temperature)
- Shape the mixture in round shape and sundried for two days
- Fry with oil

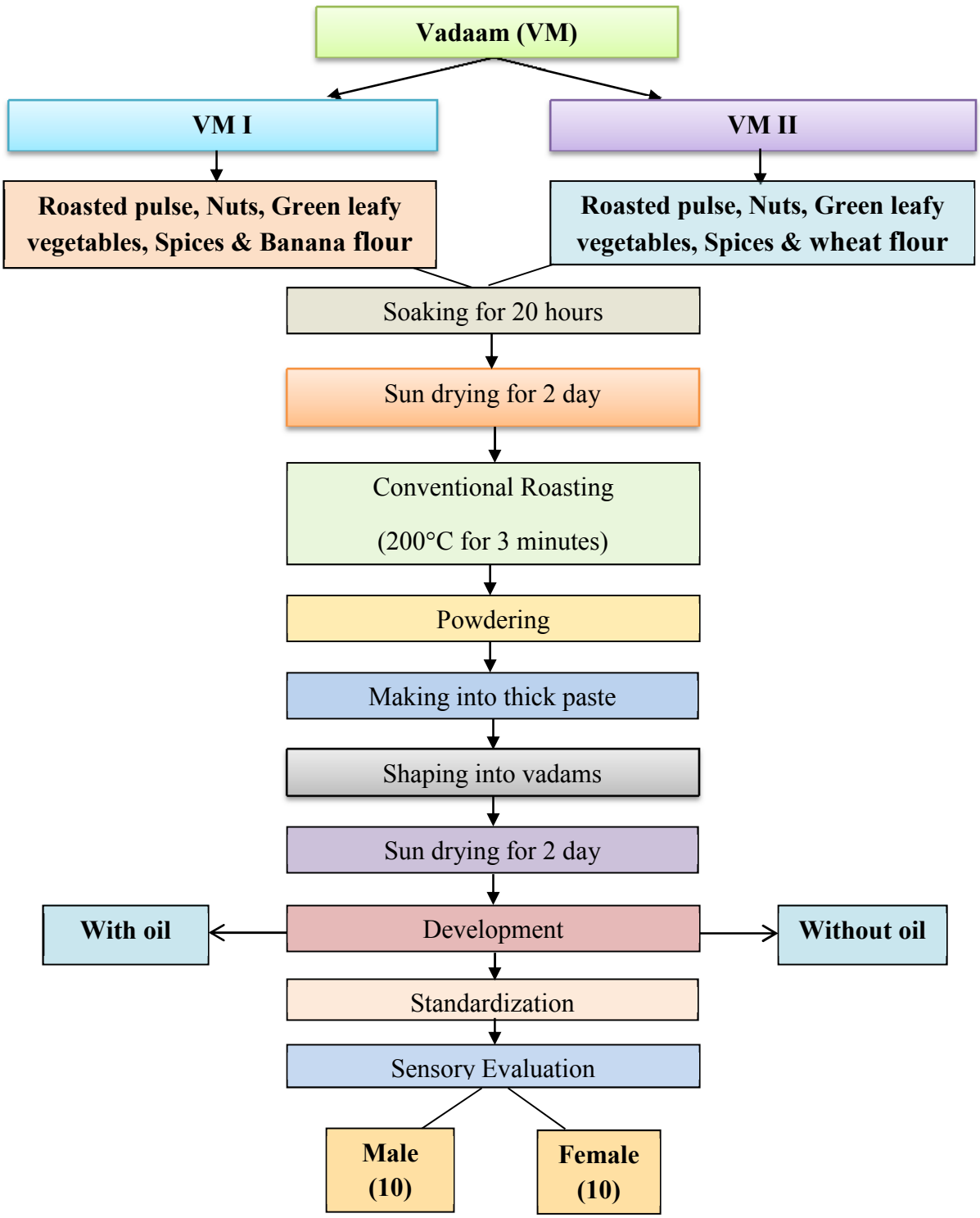
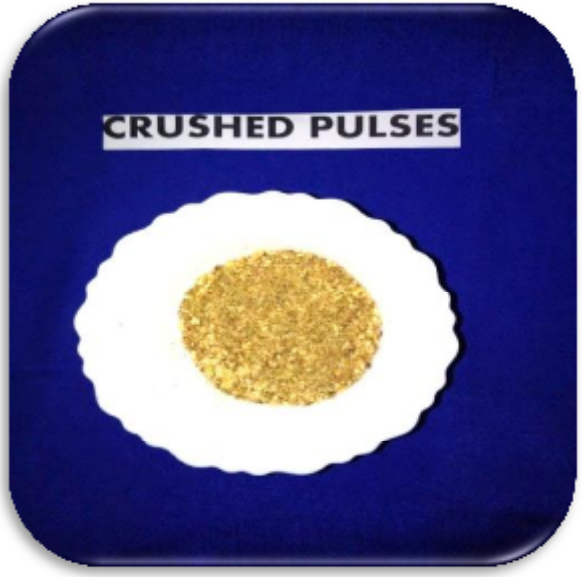


Fig. II: Flow chart of the vadaam



Roasted vadaam (without oil)

Roasted vadaam (with oil)

PLATE II: DEVELOPMENT OF VADAAM

The standardization of vadaam was carried out three times each in three different variations by yielding 100g for both variables i.e., with oil and without oil preparation. Hence, the 100g of yield gives 25g of portion per serving i.e., total number of portion is 4 respectively.

MURUKKU

Murukkku is a savoury, crunchy snack which made from rice flour and urad dal flour. Murukku is especially popular in the states of Tamilnadu, Kerala & Andhra Pradesh.

Table III
Ingredients for murukku

INGREDIENTS	QUANTITY (g/ml)	PROCESSING
Bengal gram	5	Cleaned and soaked for 20 hours
Dry pea	5	Cleaned and soaked for 12 hours
Roasted bengal gram	20	Cleaned
Brown cow pea	5	Cleaned and soaked for 12 hours
Black gram	10	Cleaned and roasted
Brown lentil	5	Cleaned and soaked for 8 hours
Green gram	5	Cleaned and roasted
Horse gram	5	Cleaned and soaked for 8 hours
Rice flour/Wheat flour	5	Powdered, roasted and sieved
Curry leaves powder	½ tsp	Cleaned and sundried
Mint leaves powder	½ tsp	Cleaned and sundried
Coriander leaves powder	½ tsp	Cleaned and sundried
Almonds	5	Cleaned and roasted
Pumpkin seeds	5	Cleaned and roasted
Turmeric powder	2	Sieved
Red chili powder	5	Sieved
Hing	3	Sieved
Salt	5	Dissolve in water and sprinkle over the ingredients
Oil (only one variation)	5	
TOTAL	100 g	
Yield = 100g Portion per serving = 25g Total number of portions = 4		

PROCEDURE

- Clean and soak the pulses overnight (Bengal gram, Dry pea, Brown cow pea, Brown lentil, Horse gram)
- Drain the water and steam for 5 minutes
- Sundry the pulses till it becomes dry
- Clean and sundry curry leaves, coriander leaves and mint leaves
- Roast all the pulses in a wok by adopting high temperature short time (HTST) method at 200°C for 3 minutes
- Roast curry leaves, coriander leaves and mint leaves
- Roast nuts (almonds and pumpkin seeds)
- Powder the roasted leaves and sieve it
- Mix all together by incorporating roasted pulses, powdered leaves, nuts and spices (Turmeric powder, Red chili powder, Asafoetida and salt)
- Powder it and steam for 5 minutes
- Make dough by adding water
- Extrude in the form of murukku
- Roast it in oil

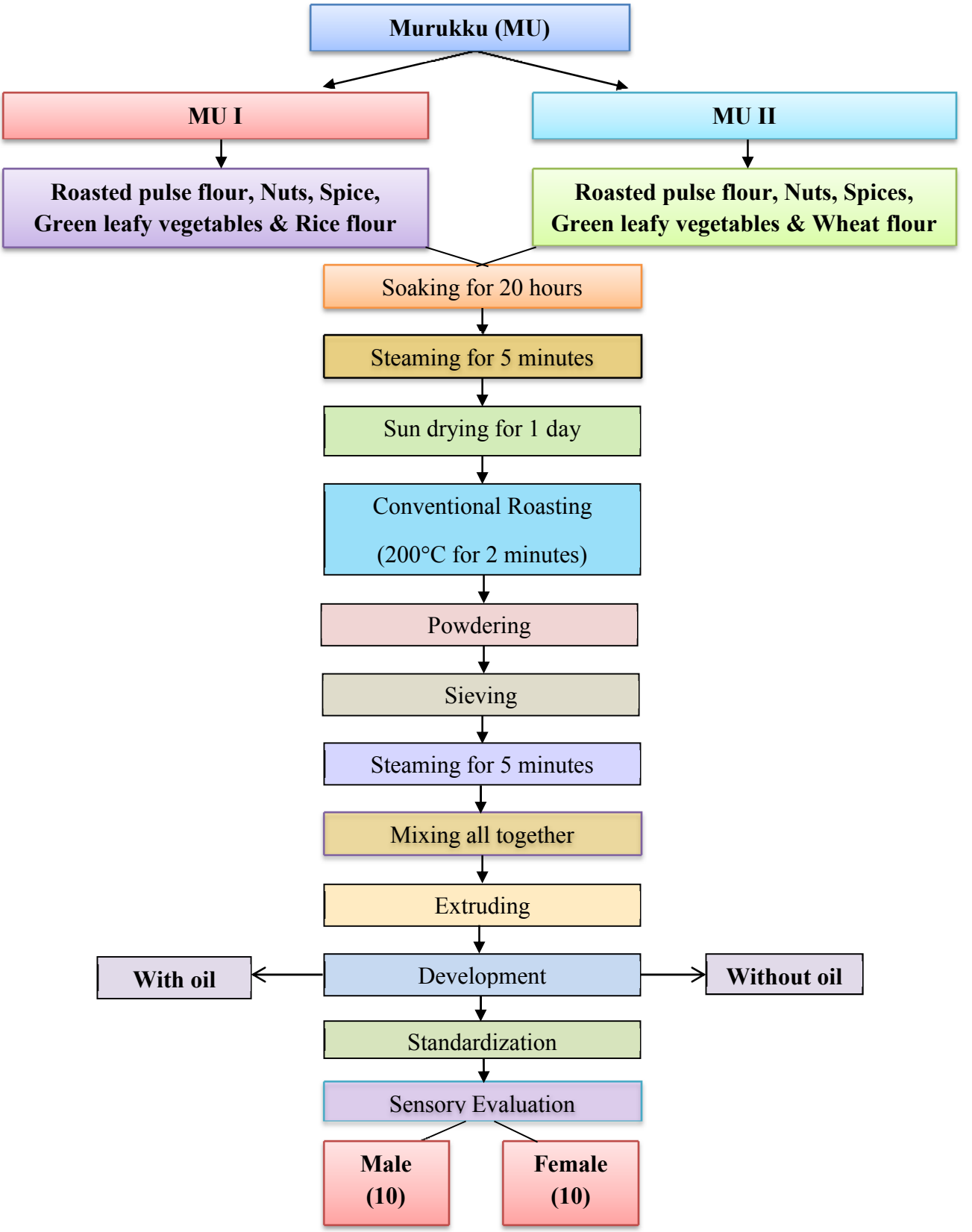
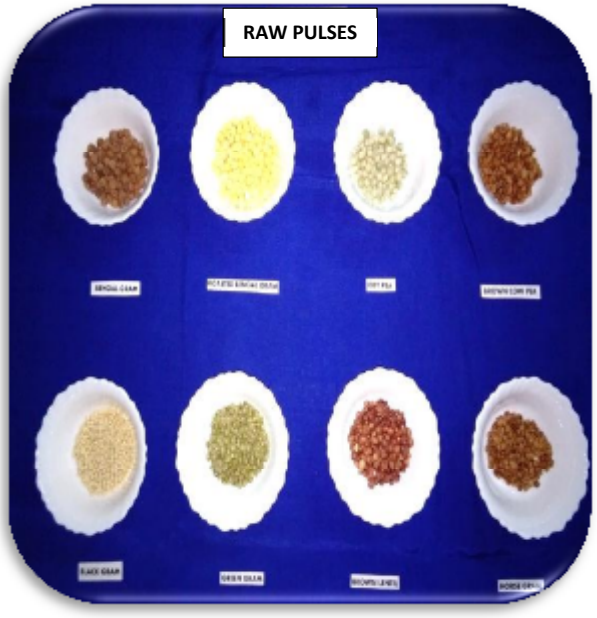


Fig. III: Flow chart of the murukku



Roasted murukku (with oil)

Roasted murukku (without oil)

PLATE III: DEVELOPMENT OF MURUKKU

The standardization of murukku was carried out three times each in three different variations by yielding 100g for both variables i.e., with oil and without oil preparation. Hence, the 100g of yield gives 25g of portion per serving i.e., total number of portion is 4 respectively.

RIBBON PAKODA

These are fried crisp ribbon shaped savory snack. They are easy to prepare and tastes good too. Ribbon pakoda is also known as ribbon murukku or Ola pakoda or nada thenkuzhal.

Table IV
Ingredients for ribbon pakoda

INGREDIENTS	QUANTITY (g/ml)	PROCESSING
Bengal gram	5	Cleaned and soaked for 20 hours
Dry pea	5	Cleaned and soaked for 12 hours
Roasted bengal gram	20	Cleaned
Brown cow pea	5	Cleaned and soaked for 12 hours
Black gram	10	Cleaned and roasted
Brown lentil	5	Cleaned and soaked for 8 hours
Green gram	5	Cleaned and roasted
Horse gram	5	Cleaned and soaked for 8 hours
Rice flour/Wheat flour	5	Powdered, roasted and sieved
Curry leaves powder	½ tsp	Cleaned and sundried
Mint leaves powder	½ tsp	Cleaned and sundried
Coriander leaves powder	½ tsp	Cleaned and sundried
Almonds	5	Cleaned and roasted
Pumpkin seeds	5	Cleaned and roasted
Turmeric powder	2	Sieved
Red chili powder	5	Sieved
Hing	3	Sieved
Salt	5	Dissolve in water and sprinkle over the ingredients
Oil (only one variation)	5	
TOTAL	100 g	
Yield = 100g Portion per serving = 25g Total number of portions = 4		

PROCEDURE

- Clean and soak the pulses overnight (Bengal gram, Dry pea, Brown cow pea, Brown lentil, Horse gram)
- Drain the water and steam for 5 minutes
- Sundry the pulses till it becomes dry
- Clean and sundry curry leaves, coriander leaves and mint leaves
- Roast all the pulses in a wok by adopting high temperature short time (HTST) method at 200°C for 3 minutes
- Roast curry leaves, coriander leaves and mint leaves
- Roast nuts (almonds and pumpkin seeds)
- Powder the roasted leaves and sieve it
- Mix all together by incorporating roasted pulses, powdered leaves, nuts and spices (Turmeric powder, Red chili powder, Asafoetida and salt)
- Powder it and steam for 5 minutes
- Make dough by adding water
- Extrude in the form of murukku
- Roast it in oil

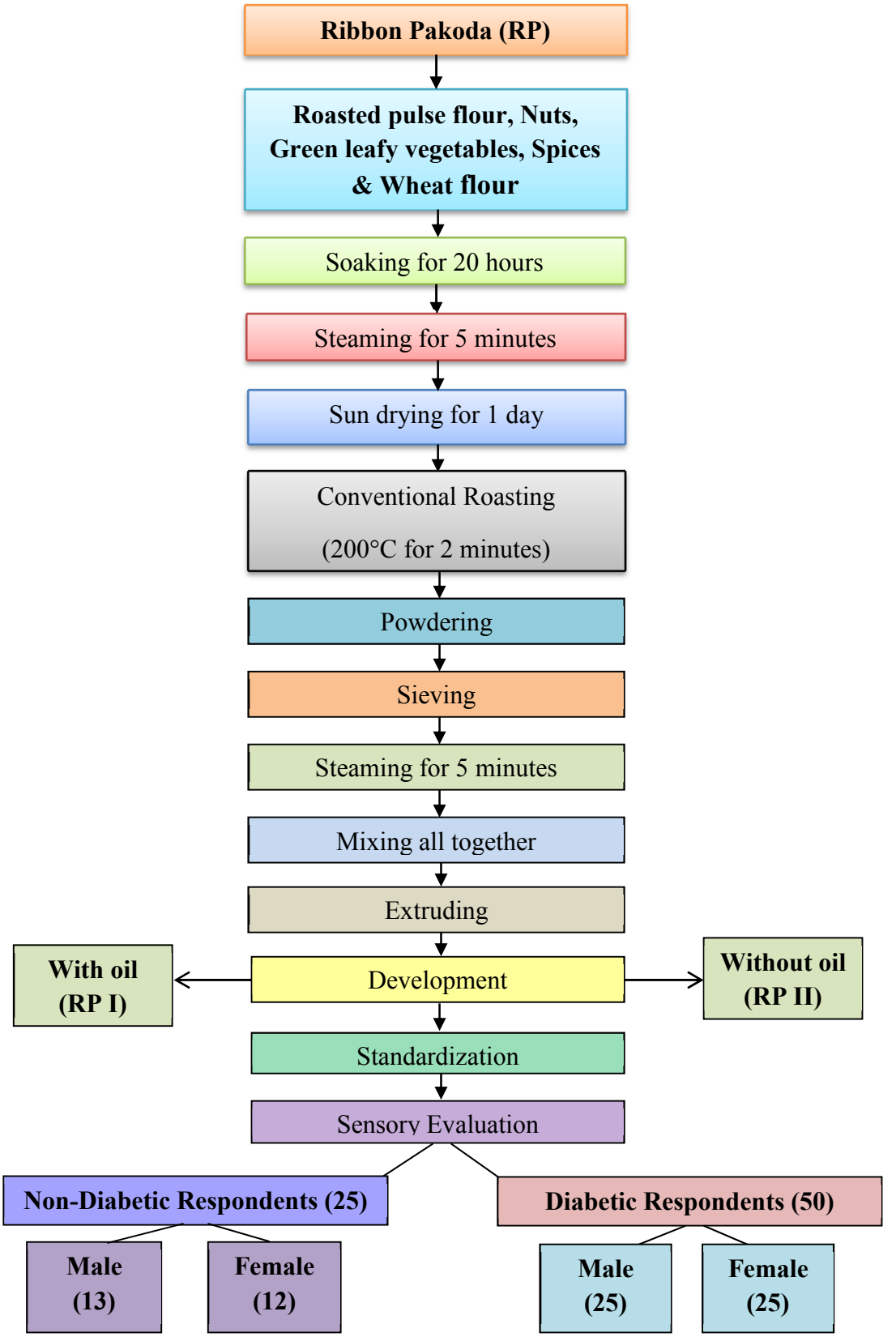
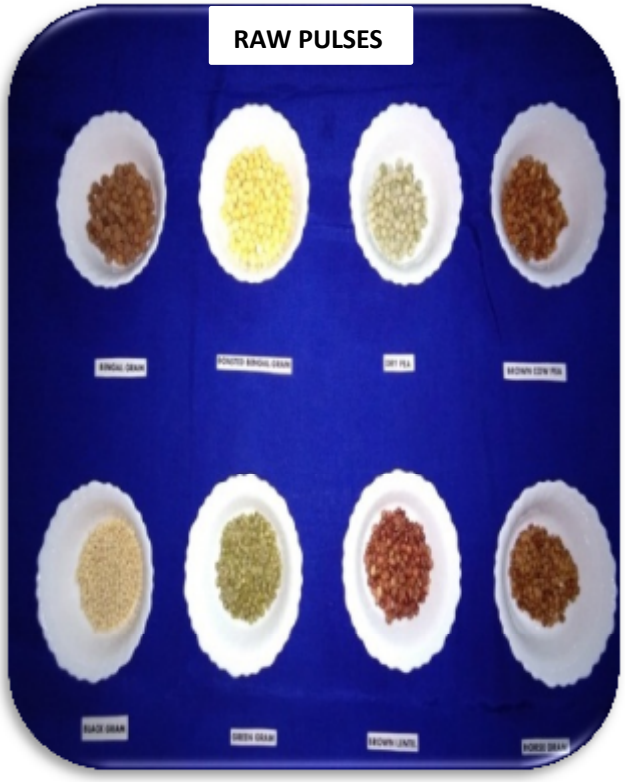


Fig. IV: Flow chart of the ribbon pakoda



Roasted Ribbon pakoda (without oil) Roasted Ribbon Pakoda (with oil)

PLATE IV: DEVELOPMENT OF RIBBON PAKODA

The standardization of ribbon pakoda was carried out three times each in three different variations by yielding 100g for both variables i.e., with oil and without oil preparation. Hence, the 100g of yield gives 25g of portion per serving i.e., total number of portion is 4 respectively.

B. SENSORY EVALUATION

The sensory evaluation of the developed four products namely whole pulse mixture, Vadaam, Murukku, and Ribbon Pakoda are described below in detail.

SENSORY EVALUATION OF WHOLE PULSE MIXTURE

The Mean scores of the acceptability of whole pulse mixture are given below:

Table V

Mean scores acceptability of whole pulse mixture (WPM 1)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
WPM 1 (With oil)	Males	7.5	7.5	6.6	6.3	7.6
	Females	7.9	8.3	7.7	7.3	8.3
WPM 1 (Without oil)	Males	7.8	7.9	6.9	7.3	6.5
	Females	8.3	8.5	7.9	7.9	7.4

Table V reveals that WPM 1 (with oil), male panel members rated high for taste (7.6) whereas, the female panel members rated color (8.3) as the best attribute. In without oil, male and female rated high in color with 7.9 and 8.5 respectively. While comparing both the variations, with oil variable rated least for texture and flavour by 6.6 and 6.3 whereas, in the second of without oil, texture and taste rated least by 6.9 and 6.5 respectively.

Table VI

Mean scores acceptability of whole pulse mixture (WPM 2)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
WPM 2 (With oil)	Males	8.3	8.3	8.5	7.9	8.5
	Females	8.7	8.2	8.3	8.2	8.6
WPM 2 (Without oil)	Males	8.4	8.3	8	7.9	8.3
	Females	8.7	7.8	8.3	8	8.5

Table VI reveals that WPM 2 (with oil), male panel members rated high for taste (8.5) and texture (8.5) whereas, the female panel members rated appearance (8.7) as the best attribute. In without oil, male and female rated high in appearance with 8.4 and 8.7 respectively. While comparing both the variations, with oil variable rated least for flavour by 7.9 and 8.2 whereas, in the second of without oil, flavour and color rated least by 7.9 and 7.8 respectively.

Table VII

Mean scores acceptability of whole pulse mixture (WPM 3)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
WPM 3 (With oil)	Males	8.5	8.3	8.9	8.2	9.1
	Females	8.8	8.8	8.7	8.6	8.9
WPM 3 (Without oil)	Males	8.6	8.8	8.7	8.5	8.8
	Females	8.7	8.1	8.6	8.5	8.7

Table VII reveals that WPM 3 (with oil), male panel members rated high for taste (9.1) and texture (8.9) whereas, the female panel members rated taste (9.1) and

color (8.8) as the best attribute. In without oil, male have rated high in taste (8.8), color (8.7) and texture (8.7) and females have rated appearance (8.7), texture (8.5) and taste (8.5) respectively. While comparing both the variations, with oil variable rated least for flavour by 8.2 and 8.6 whereas, in the second of without oil, flavour and color rated least by 8.5 and 8.1 respectively.

Table VIII

Overall acceptability of whole pulse mixture

VARIATIONS	TOTAL ACCEPTABILITY (50)
WPM 1	38
WPM 2	41
WPM 3	43

Fig. V

Overall acceptability of whole pulse mixture

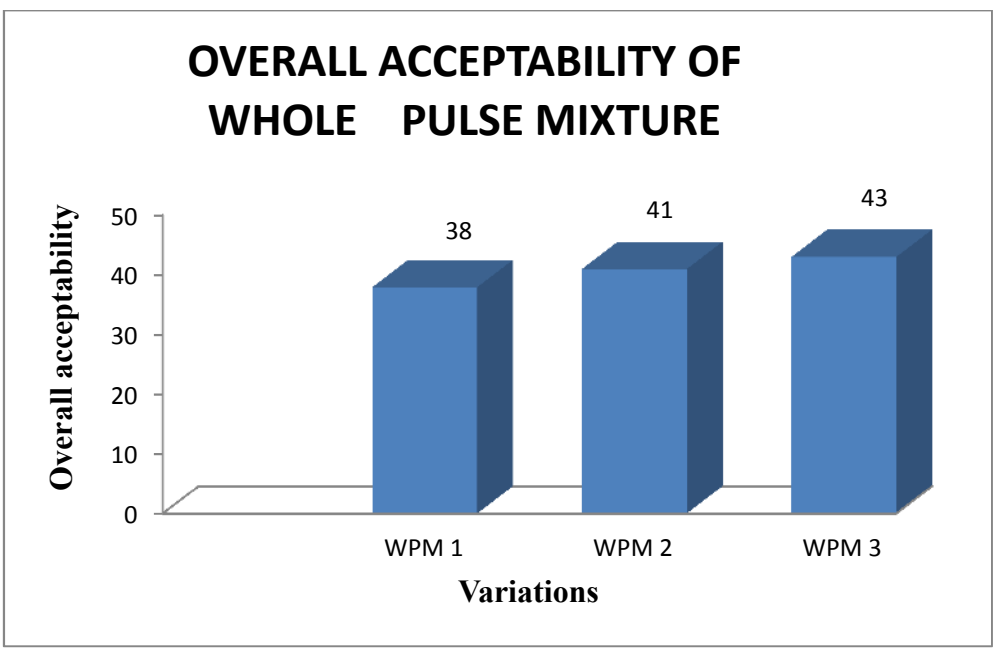


Table VIII reveals that overall acceptability of whole pulse mixture indicated that the WPM 3 was most acceptable with a score of 43 and WPM 1 was least. The diminished score was greatly due to the factor of flavor and taste.

SENSORY EVALUATION OF VADAAM

The Mean scores of the acceptability of vadaam are given below:

Table IX
Mean scores acceptability of vadaam (VM 1)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
VM 1 (With oil)	Males	5.2	5	4.6	4.5	4
	Females	5	5.4	5.6	5.3	4.1
VM 1 (Without oil)	Males	5.2	5.4	5.2	4.7	4.1
	Females	4.7	4.8	5.1	4.5	3.7

Table IX reveals that VM 1 (with oil), male panel members rated high for appearance (5.2) whereas, the female panel members rated texture (5.6) as the best attribute. In without oil, male and female rated high in color with 5.4 and 4.8 respectively. While comparing both the variations, with oil variable rated least for taste by 4 and 4.1 whereas, in the second of without oil, taste rated least by 4.1 and 3.7 respectively.

Table X
Mean scores acceptability of vadaam (VM 2)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
VM 2 (With oil)	Males	5.7	5.1	5.2	5.6	4.1
	Females	4.3	3.8	4.5	4	3.2
VM 2 (Without oil)	Males	4.8	4.2	5.2	4.5	3.9
	Females	3.8	3.7	4.3	3.7	3.6

Table X reveals that VM 2 (with oil), male panel members rated high for appearance (5.7) whereas, the female panel members rated texture (4.5) as the best attribute. In without oil, male and female rated high in texture with 5.2 and 4.3 respectively. While comparing both the variations, with oil variable rated least for taste by 4.1 and 3.2 whereas, in the second of without oil, taste rated least by 3.9 and 3.6 respectively.

Table XI

Overall acceptability of vadaam

VARIATIONS	TOTAL ACCEPTABILITY (50)
VM 1	24
VM 2	22

Fig. VI

Overall acceptability of Vadaam

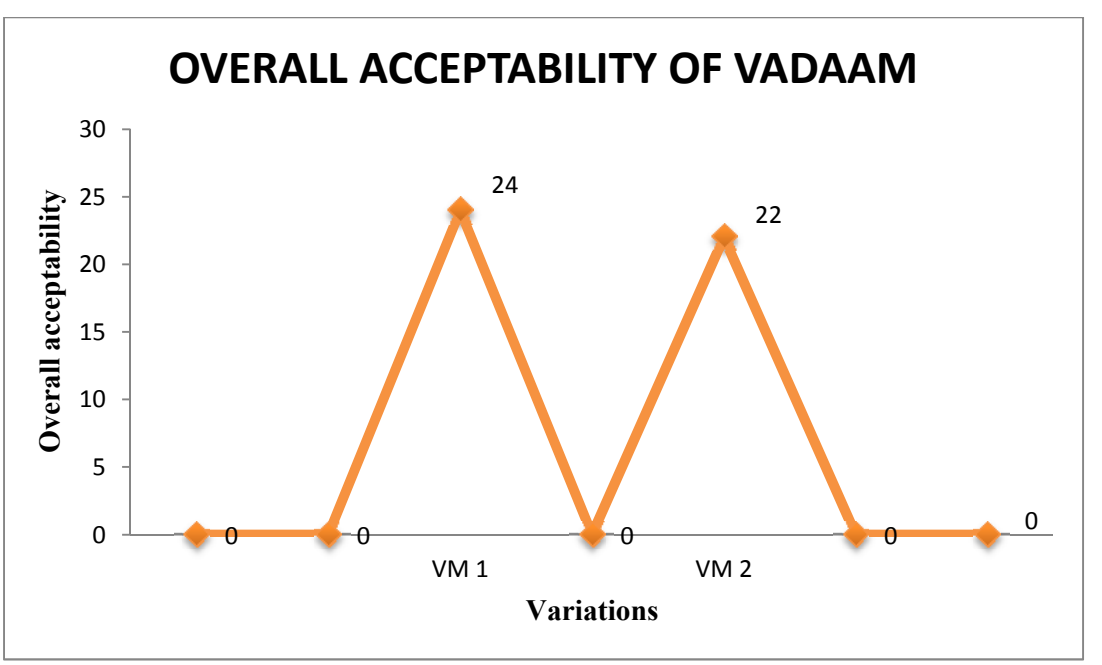


Table XI reveals that overall acceptability of vadaam indicated that the VM 1 was most acceptable with a score of 24 and VM 2 was least. The diminished score was greatly due to the factor of taste.

SENSORY EVALUATION OF MURUKKU

The Mean scores of the acceptability of murukku are given below:

Table XII

Mean scores acceptability of murukku (MU 1)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
MU 1 (With oil)	Males	8.6	7	7.6	8.2	8.8
	Females	8.4	7.5	7.8	7.4	8.4
MU 1 (Without oil)	Males	8.6	7.6	7.8	8	9
	Females	8.9	8.4	8.3	8.3	8.7

Table XII reveals that MU 1 (with oil), male panel members rated high for taste (8.8) whereas, the female panel members rated appearance and taste by 8.4 and 8.4 as the best attribute. In without oil, male and female rated high in taste and appearance with 9 and 8.7 respectively. While comparing both the variations, with oil variable rated least for color and flavour by 7 and 7.4 whereas, in the second of without oil, color rated least by 7.6 respectively.

Table XIII

Mean scores acceptability of murukku (MU 2)

VARIATIONS	GENDER	MEAN SCORES				
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)
MU 2 (With oil)	Males	8	7.5	7.4	7.8	8.5
	Females	8.7	8.1	7.9	7.9	9.1
MU 2 (Without oil)	Males	8.4	7.5	7.7	8.2	8.7
	Females	8.4	7.1	7.4	8.2	8.7

Table XIII reveals that MU 2 (with oil), male panel members rated high for taste (8.5) whereas, the female panel members rated taste by 9.1 as the best attribute. In without oil, male and female rated high in taste with 8.7 and 8.7 respectively. While comparing both the variations, with oil variable rated least for texture by 7.4 whereas, in the second of without oil, color rated least by 7.5 and 7.1 respectively.

Table XIV

Overall acceptability of murukku

VARIATIONS	TOTAL ACCEPTABILITY (50)
MU 1	41
MU 2	40

Fig. VII

Overall acceptability of murukku

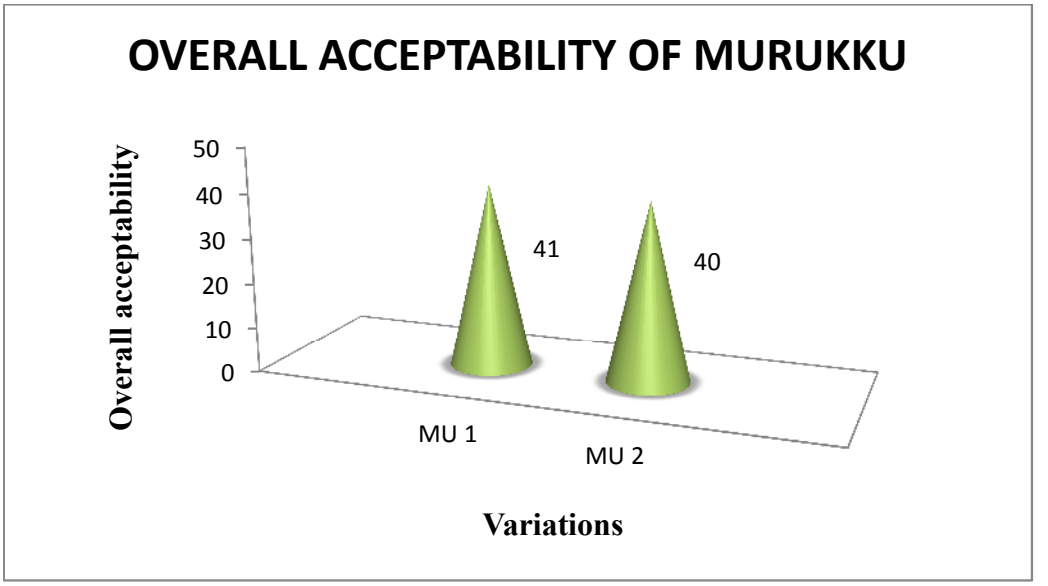


Table XIV reveals that overall acceptability of murukku indicated that the MU 1 was most acceptable with a score of 41 and MU 2 was least. The diminished score was greatly due to the factor of texture and color.

SENSORY EVALUATION OF RIBBON PAKODA

The Mean scores of the acceptability of ribbon pakoda are given below:

Table XV

Mean scores and overall acceptability of ribbon pakoda (RP) by non-diabetics

VARIATIONS	GENDER	MEAN SCORES					
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)	OVERALL SCORES
RP 1 (With oil)	Males	8.9	8.7	8.6	9	9	44
	Females	8.7	8.5	8.5	8.5	9.5	
RP 2 (Without oil)	Males	9	8.8	8.6	9	9.5	
	Females	8.8	8.8	8.6	8.6	9.8	

Table XV reveals that RP 1 (with oil), male panel members rated high for flavour (9) and taste (9) whereas, the female panel members rated appearance (8.7) as the best attribute. In without oil, male and female rated high in taste and appearance with 9 and 8.7 respectively. While comparing both the variations, with oil variable rated least for color, texture and flavour by 8.5 whereas, in the second of without oil, texture and flavour rated least by 8.6 respectively.

The overall acceptability of ribbon pakoda by non-diabetics indicated that the RP was most acceptable with a score of 44 while comparing both with oil and without oil variables and RP obtained high score among four developed products.

Table XVI

Mean scores and overall acceptability of ribbon pakoda (RP) by diabetics

VARIATIONS	GENDER	MEAN SCORES					
		APPEARANCE (10)	COLOR (10)	TEXTURE (10)	FLAVOUR (10)	TASTE (10)	OVERALL SCORES
RP 1 (With oil)	Males	8.52	7.92	8.04	8.24	8.72	42
	Females	8.36	8.08	8.16	8.6	9.16	
RP 2 (Without oil)	Males	8.4	8.04	8.4	8.92	9.32	
	Females	8.52	8	8.12	8.56	9.28	

Fig. VIII

Overall acceptability of ribbon pakoda

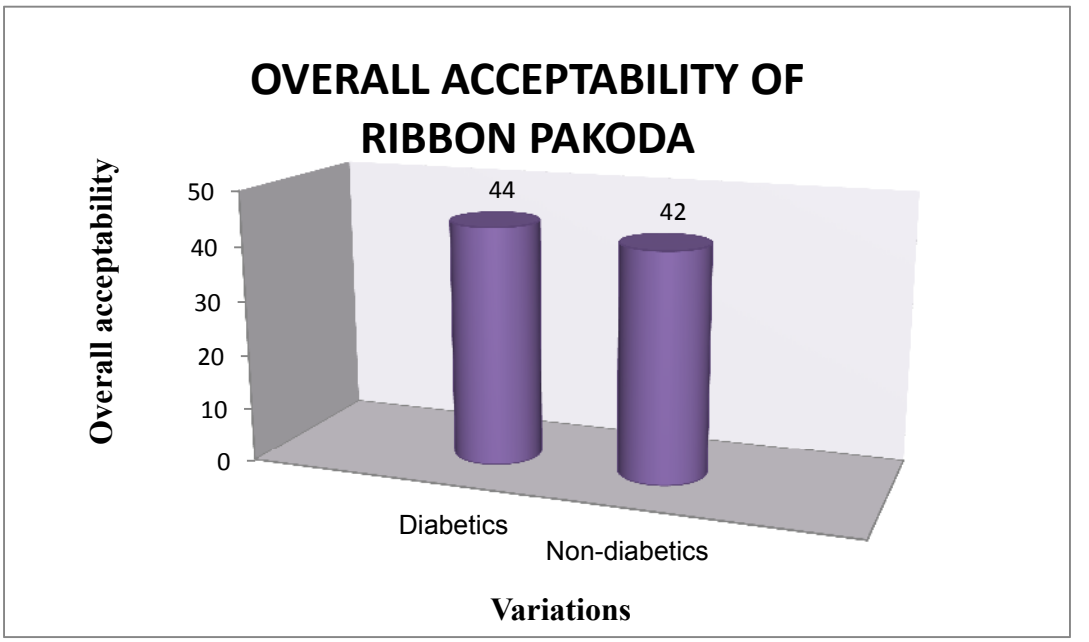


Table XVI reveals that RP 1 (with oil), male panel members rated high for taste (8.7) whereas, the female panel members rated taste (9) as the best attribute. In without oil, male and female rated high in taste with 9 and 9 respectively. While comparing both the variations, with oil variable rated least for color and texture by 8 whereas, in the second of without oil, color rated least by 8 respectively.

The overall acceptability of ribbon pakoda by diabetics indicated that the RP was most acceptable with a score of 42 while comparing both with oil and without oil variables and among developed products, RP have rated high score in all the attributes. And also, RP by diabetes is 2 percent less than the non-diabetics.

Table XVII

ANOVA of ribbon pakoda RP I and RP II by males

HEDONIC SCALE	TOTAL ACCEPTABILITY	F VALUE	SIG. VALUE
Appearance	8.95	1.256	.274^{NS}
Color	8.75	.154	.698^{NS}
Texture	8.6	.118	.735^{NS}
Flavor	9	.000	1.000^{NS}
Taste	9.25	.585	.452^{NS}

NS = Not significant

ANOVA test of table XVII shows that, there is a no significant difference in appearance, color, texture, flavour and taste as scored by the males.

Table XVIII

ANOVA of ribbon pakoda RP I and RP II by females

HEDONIC SCALE	TOTAL ACCEPTABILITY	F VALUE	SIG. VALUE
Appearance	8.75	.234	.633^{NS}
Color	8.65	1.800	.193^{NS}
Texture	8.55	.164	.689^{NS}
Flavor	8.55	.164	.689^{NS}
Taste	3.86	1.800	.193^{NS}

NS = Not significant

ANOVA test of table XVIII shows that, there is a no significance difference in appearance, color, texture, flavour and taste as scored by the females.

Table XIX

ANOVA of ribbon pakoda RP I and RP II by diabetic males

HEDONIC SCALE	TOTAL ACCEPTABILITY	F VALUE	SIG. VALUE
Appearance	8.46	.532	.469^{NS}
Color	7.98	.379	.541^{NS}
Texture	8.22	4.585	.037 **
Flavor	8.58	19.267	.000 *
Taste	9.02	11.688	.001 *

*** = 1 % ** = 5% NS = Not significant**

ANOVA test of table XIX shows that, there is significant difference in flavour and taste of ribbon pakoda at 1 % and texture at 5 % level. While, there is no significance difference in appearance and color as scored by the diabetic males.

Table XX

ANOVA of ribbon pakoda RP I and RP II by diabetic females

HEDONIC SCALE	TOTAL ACCEPTABILITY	F VALUE	SIG. VALUE
Appearance	8.44	.960	.332^{NS}
Color	8.04	.242	.625^{NS}
Texture	8.14	.044	.835^{NS}
Flavor	8.58	.059	.808^{NS}
Taste	9.22	.600	.442^{NS}

NS = Not significant

ANOVA test of table XX shows that, there is a no significance difference in appearance, color, texture, flavour and taste as scored by the diabetic females.

C. NUTRIENT CONTENT OF THE DEVELOPED PRODUCTS

The nutrient content of the developed four products namely whole pulse mixture, Vadaam, Murukku, and Ribbon Pakoda are described below in detail.

NUTRIENT CONTENT OF WHOLE PULSE MIXTURE

Table XXI reveals the nutrient content of whole pulse mixture is given below:

Table XXI
Nutrient content of whole pulse mixture

INGREDIENTS	QUANATITY (g/ml)	ENERGY (Kcal)	CHO (g)	FIBER (g)	FAT (g)	PROTEIN (g)
Bengal gram	1	3	0.3	0.2	0.05	0.18
Dry pea	1	3.1	0.4	0.1	0.01	0.2
Roasted bengal gram	5	15	1.9	1.2	0.19	0.93
Brown cow pea	1	3	0.5	0.1	0.01	0.2
Black gram	3	9	1	0.6	0.04	0.8
Brown lentil	1	3.1	0.4	0.08	0.006	0.2
Green gram	1	3.07	0.4	0.1	0.01	0.2
Horse gram	1	3.4	0.5	0.07	0.006	0.21
Curry leaves powder	0.5	0.33	0.02	0.16	0.16	0.03
Mint leaves powder	0.5	0.19	0.01	0.02	0.006	0.02
Coriander leaves powder	0.5	0.16	0.005	0.02	0.003	0.01
Almonds	1	6.3	0.03	0.13	0.5	0.1
Pumpkin seeds	1	5.8	0.15	0.002	0.47	0.2
Turmeric powder	1	3	0.4	0.2	0.05	0.07
Red chili powder	2	4.9	0.2	1.009	0.06	0.5
Hing	1	3.4	0.7	0.05	0.01	0.06
Salt	2	-	-	-	-	-
Oil (only for one variation)	1	9	0	0	1	0
With oil	**25g**	**76**	**8**	**4**	**3**	**4**
Without oil		**70**	**8**	**4**	**2**	**4**

The grand total of the calculated nutritive value of whole pulse mixture for 25g with oil was 76 kcal in terms of energy, 80 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g respectively . Whereas, without oil contain 70 kcal in terms of energy, 8 g of carbohydrate, and 2 g of fat. While in case of fiber and protein the nutritive value was 4 g and 4 g respectively.

NUTRIENT CONTENT OF VADAAM

Table XXII reveals the nutrient content of vadaam is given below:

Table XXII

Nutrient content of vadaam

INGREDIENTS	QUANTITY (g/ml)	ENERGY (Kcal)	CHO (g)	FIBER (g)	FAT (g)	PROTEIN (g)
Bengal gram	1	3.002	0.3	0.2	0.05	0.1
Dry pea	1	3.1	0.4	0.1	0.01	0.2
Roasted bengal gram	5	15	1.9	1.2	0.1	0.9
Brown cow pea	1	3.3	0.5	0.1	0.01	0.2
Black gram	3	9.1	1.3	0.6	0.04	0.8
Brown lentil	1	3.12	0.4	0.08	0.006	0.2
Green gram	1	3.07	0.4	0.1	0.01	0.2
Horse gram	1	3.4	0.5	0.07	0.006	0.2
Banana flour	1	0.2	0.05	0.01	0	0.01
Curry leaves powder	0.5	0.3	0.02	0.1	0.1	0.03
Mint leaves powder	0.5	0.1	0.01	0.02	0.006	0.02
Coriander leaves powder	0.5	0.1	0.005	0.02	0.003	0.01
Almonds	1	6.3	0.03	0.1	0.5	0.1
Pumpkin seeds	1	5.8	0.1	0.002	0.4	0.2
Turmeric powder	1	2.9	0.4	0.2	0.05	0.07
Red chili powder	2	4.9	0.2	1.009	0.06	0.5
Hing	1	3.4	0.7	0.05	0.01	0.06
Salt	2	-	-	-	-	-
Oil (only for one variation)	1	9	0	0	1	0
With oil	**25g**	**77**	**8**	**4**	**3**	**4**
Without oil		**71**	**8**	**4**	**2**	**4**

The grand total of the calculated nutritive value of vadaam for 25g with oil was 77 kcal in terms of energy, 80 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g respectively . Whereas, without oil contain 71 kcal in terms of energy, 8 g of carbohydrate, 4 g of fiber, 2 g of fat and 4 g of protein respectively.

NUTRIENT CONTENT OF MURUKKU

Table XXIII reveals the nutrient content of murukku is given below:

Table XXIII
Nutrient content of murukku

INGREDIENTS	QUANTITY (g/ml)	ENERGY (Kcal)	CHO (g)	FIBER (g)	FAT (g)	PROTEIN (g)
Bengal gram	1	3.002	0.3	0.2	0.05	0.1
Dry pea	1	3.1	0.4	0.1	0.01	0.2
Roasted bengal gram	5	15	1.9	1.2	0.1	0.9
Brown cow pea	1	3.3	0.5	0.1	0.01	0.2
Black gram	3	9.1	1.3	0.6	0.04	0.8
Brown lentil	1	3.1	0.4	0.08	0.006	0.2
Green gram	1	3.07	0.4	0.1	0.01	0.2
Horse gram	1	3.4	0.5	0.07	0.006	0.2
Rice flour	1	3.45	0.78	0	0.01	0.07
Curry leaves powder	0.5	0.3	0.02	0.1	0.1	0.03
Mint leaves powder	0.5	0.1	0.01	0.02	0.006	0.02
Coriander leaves powder	0.5	0.1	0.005	0.02	0.003	0.01
Almonds	1	6.3	0.03	0.13	0.5	0.1
Pumpkin seeds	1	5.8	0.1	0.002	0.4	0.2
Turmeric powder	1	2.9	0.4	0.2	0.05	0.07
Red chili powder	2	4.9	0.2	1.009	0.06	0.5
Hing	1	3.4	0.7	0.05	0.01	0.06
Salt	2	-	-	-	-	-
Oil (only for one variation)	1	9	0	0	1	0
With oil	**25g**	**80**	**8**	**4**	**3**	**4**
Without oil		**74**	**10**	**5**	**2**	**4**

The grand total of the calculated nutritive value of ribbon pakoda for 25g with oil was 80 kcal in terms of energy, 80 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g respectively . Whereas, without oil contain 74 kcal in terms of energy, 10 g of carbohydrate, 5 g of fiber, 2 g of fat and 4 g of protein respectively.

NUTRIENT CONTENT OF RIBBON PAKODA

Table XXIV reveals the nutrient content of ribbon pakoda is given below:

Table XXIV

Nutrient content of ribbon pakoda

INGREDIENTS	QUANTITY (g/ml)	ENERGY (Kcal)	CHO (g)	FIBER (g)	FAT (g)	PROTEIN (g)
Bengal gram	1	3.002	0.3	0.2	0.05	0.1
Dry pea	1	3.1	0.4	0.1	0.01	0.2
Roasted bengal gram	5	15	1.9	1.2	0.1	0.9
Brown cow pea	1	3.3	0.5	0.1	0.01	0.2
Black gram	3	9.1	1.3	0.6	0.04	0.8
Brown lentil	1	3.1	0.4	0.08	0.006	0.2
Green gram	1	3.07	0.4	0.1	0.01	0.2
Horse gram	1	3.4	0.5	0.07	0.006	0.2
Whole wheat	1	3.3	0.6	0.1	0.01	0.1
Curry leaves powder	0.5	0.3	0.02	0.1	0.1	0.03
Mint leaves powder	0.5	0.1	0.01	0.02	0.006	0.02
Coriander leaves powder	0.5	0.1	0.005	0.02	0.003	0.01
Almonds	1	6.3	0.03	0.13	0.5	0.1
Pumpkin seeds	1	5.8	0.1	0.002	0.4	0.2
Turmeric powder	1	2.9	0.4	0.2	0.05	0.07
Red chili powder	2	4.9	0.2	1.009	0.06	0.5
Hing	1	3.4	0.7	0.05	0.01	0.06
Salt	2	-	-	-	-	-
Oil (only for one variation)	1	9	0	0	1	0
With oil	**25g**	**80**	**8**	**4**	**3**	**4**
Without oil		**74**	**10**	**5**	**2**	**4**

The grand total of the calculated nutritive value of ribbon pakoda for 25g with oil was 80 kcal in terms of energy, 80 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g respectively . Whereas, without oil contain 74 kcal in terms of energy, 10 g of carbohydrate, 5 g of fiber, 2 g of fat and 4 g of protein respectively.

Table XXV

Overall acceptability of pulse based low fat snacks

PRODUCTS	OVERALL SCORES	NUTRIENT CONTENT					
		ENERGY (Kcals)		PROTEIN (g)		FAT (g)	
		With oil	Without Oil	With oil	Without Oil	With oil	Without Oil
Whole pulse mixture	43	76	70	4	4	3	2
Vadaam	24	77	71	4	4	3	2
Murukku	41	80	74	4	4	3	2
Ribbon pakoda	44	80	74	4	4	3	2

Table XXV gives details on the overall acceptability of pulse based low fat snacks. Among the four developed products, ribbon pakoda was rated high with 44 followed by whole pulse mixture with 43. The least score was obtained for vadaam which is 24. The preparation of the products was done with the same ingredients and the procedure carried out was different, hence the nutrient content of the four products without using oil namely energy, protein anf fat values were almost similar for 25 g.

CHAPTER V

SUMMARY AND CONCLUSION

Pulses are an important source of protein in the diet, which was also known as poor man's meat. Pulses were a major part of dietary habits of ancient Indians and also it were given priority not just as food but also as medicine to cure chronic diseases such as diabetes mellitus. Therefore, it is used to develop ready to eat (RTE) products with low fat content and making applicable to consume by diabetic individuals. In the dietary management of diabetes, quantity as well as quality of fat and carbohydrate intake must be carefully considered because they may not always grant desirable health benefits. In addition, today's consumer is looking for convenient, high quality, nutritive, minimally processed, innovative and ready-to-eat products. Keeping this in view, an attempt was made to develop and assess the various quality parameters of Ready-To-Eat (RTE) snacks based on low fat content and foods from four food groups were selected namely cereals, pulses, green leafy vegetables, nuts and oil seeds, and spices and condiments. The primary objective of the study is to develop low fat snacks suitable for diabetics and the secondary objective of the study is to standardize the developed products and study the acceptability.

Pulses were the ingredients selected for the development of the products and four commonly consumed snacks like whole pulse mixture (combination of one cereal and pulses), Vadaam, Murukku, and Ribbon Pakoda were developed. It was developed using different permutation and combination of ingredients to obtain the acceptable product. With the aim to standardize, the snacks were prepared repeatedly until uniform acceptable results were obtained. Standardized recipe of the developed snacks consisted of following basic ingredients namely whole wheat, bengal gram, black gram, dry pea, brown cowpea, green gram, horse gram, whole Lentil, almonds, pumpkin seeds, curry leaves, coriander leaves, mint leaves, turmeric powder, asafoetida, red chili powder and

salt. Hence, organoleptic evaluation of the snacks was conducted with score card of 9-point hedonic scale.

The salient findings of the study are:

- The procedures and methods towards the development of whole pulse mixture, vadaam, murukku and ribbon pakoda was carried out three times each in three different variations by yielding 100g for both variables i.e., with oil and without oil preparation.
- The 100g of yield of the four products gave a total of 4 number of portion with 25g of portion per serving.
- Mean scores acceptability of whole pulse mixture (WPM 1) was rated high with color (8.5) and taste (8.3).
- Mean scores acceptability of whole pulse mixture (WPM 2) was rated high with taste (8.6), texture (8.5) and appearance (8.7) as the best attribute.
- Mean scores acceptability of whole pulse mixture (WPM 3) was rated high for taste (9.1), texture (8.9) and color (8.8) as the best attribute.
- Overall acceptability of whole pulse mixture indicated that the WPM 3 was most acceptable with a score of 43 among other two variations respectively. Hence, this variation was carried out for further experiment.
- The nutrient content of whole pulse mixture for 25g with oil was 76 kcal in terms of energy, 8 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g. Whereas, without oil contain 70 kcal in terms of energy, 8 g of carbohydrate, 2 g of fat, and in case of fiber and protein the nutritive value was 4g and 4g.
- Mean scores acceptability of vadaam (VM 1) was rated high for appearance (5.2) and texture (5.6) as the appreciable characteristics.
- Mean scores acceptability of vadaam (VM 2) was rated high for appearance (5.7) and texture (4.1) as the best attribute.

- Hence, overall acceptability of vadaam project as VM 1 was most acceptable with a score of 24 and VM 2 was least with 2 percent.
- The nutrient content of vadaam for 25g with oil was 77 kcal in terms of energy, 8 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g. Whereas, without oil contain 71 kcal in terms of energy, 8 g of carbohydrate, 2g of fat, and in case of fiber and protein the nutritive value was 4g and 4g.
- The mean scores of the acceptability of murukku (MU 1 was rated high for taste (9) and appearance (8.9) as the best attribute.
- Mean scores acceptability of murukku (MU 2) have given the most acceptable review for taste (9.1) with high score of rating.
- Overall acceptability of murukku indicated that the MU 1 was most acceptable with a score of 41 and MU 2 was least with 1 percent due to the factor of texture and color.
- The nutrient content of murukku for 25g with oil was 80 kcal in terms of energy, 8 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g. Whereas, without oil contain 74 kcal in terms of energy, 10 g of carbohydrate, 2 g of fat, 5 g of fiber and 4 g of protein.
- Mean scores acceptability of ribbon pakoda (RP) by non-diabetics shows that taste (9.8), flavour (9) and appearance (9) were the most acceptable in ratio. Hence, overall acceptability was rated with a score of 44, which is high score obtained among four developed products.
- Mean scores acceptability of ribbon pakoda (RP) by diabetics shows that taste (9.1) was the most acceptable element. Hence, overall acceptability rated with a score of 42, which is less than 2 percent with non-diabetics.
- One way ANOVA test showed that there is no significant difference in appearance, color, texture, flavour and taste as scored by the non-diabetics.
- A significant difference in flavour and taste at 1percent and texture at 5 percent level, was noted for diabetic males. There was no significant difference in appearance, color, texture, flavour and taste for ribbon pakoda.

- Ribbon pakoda among the four developed snacks obtained high scores for overall acceptability.
- The nutrient content of ribbon pakoda for 25g with oil was 80 kcal in terms of energy, 80 g of carbohydrate, 3 g of fat while, in case of fiber and protein the nutritive value was 4g and 4g. Whereas, without oil contain 74 kcal in terms of energy, 10 g of carbohydrate, 5 g of fiber, 2 g of fat and 4 g of protein respectively.

CONCLUSION

Pulses are considered as super foods due to the low glycemic index (GI) and their health benefits. Pulse based low fat snacks are ideal for diabetics because controlling blood sugar after each meal is important. Locally available snacks can also be prepared by adapting dry roasting method (microwave oven) without using oil or using less amount of oil. Therefore, a judicious combination of convenience, cheaper and nutritious food in the form of pulse based Ready-To-Eat snacks is not only the choice for the diabetics but also it is a beneficial step to prevent diabetes.

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APPENDIX - 1

HEDONIC RATING TEST

Name: Date:

Gender:

Age:

Taste these samples and check how much you like or dislike each one and rate these out of 10. Use the appropriate scale to show your attitude by checking at the point that best describes your feelings about the sample. Please give a reason for this attitude. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us.

NAME OF THE PRODUCT	APPEARANCE (1-10)	COLOUR (1-10)	TEXTURE (1-10)	FLAVOR (1-10)	TASTE (1-10)
V1					
V2					

SIGNATURE OF THE PANELIST

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women

Deemed to be University Under category 'A' By MHRD, (Estd. u/s 3 of UGC Act 1956)

Re Accredited with 'A' Grade By NAAC, Recognised by UGC Under Section 12 B

Coimbatore - 641043, Tamil Nadu, India

24 January 2019

To
Ms. Aarathi Krishna
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Aarathi Krishna,

Ref: Your proposal No.IHEC /18-19/FSMD /01 entitled "Organoleptic Evaluation of Pulse Based Low Fat Snacks for Diabetics" submitted for approval to the IHEC on 30.09.18.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No.IHEC /18-19/FSMD /01 entitled "Organoleptic Evaluation of Pulse Based Low Fat Snacks for Diabetics" submitted by you. The Approval number for the same is AUW/ IHEC/FSMD-18-19/XPD/01.

We wish you all the best in your research endeavours.

Regards,

V. Uma Mageshwari

Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee